# POWER

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## It Costs Too Much

*By* Rufus T. Strohm

Old Titus Wacks took foolish pride
In being stingy as the deuce;
He wouldn't throw a thing aside
Until it broke from constant use;
His ancient grates let fuel through
In quantities that beat the Dutch,
But Titus wouldn't purchase new
Because he thought they cost too much.

His engineer proposed to buy
A gage to indicate the draft,
But Titus only winked his eye
In taunting mockery, and laughed.
His conscience, like his pocketbook,
Was unresponsive to the touch;
Improvements never got a look
Because he felt they cost too much.

Against a meter for the steam
He set his heart like adamant;
He wouldn't hear to any scheme
Of records for his power plant;
He drew his purse-strings hard and tight
And held them with a miser's clutch
When salesmen started to recite,
Because devices cost so much.

Alas! There came a sorry day
When heedless waste its harvest bore—
The sheriff chanced to pass that way
And nailed a notice on the door.
Too late old Titus came to see
That gages, meters, charts and such
Contribute to economy
And that their absence costs too much.

# Investigation of Breakdown of 30,000-Kw. Turbine

THE accident to the 30,000-kw. turbine in the Schuylkill plant of the Philadelphia Electric Co. occurred on Saturday morning, Sept. 3, 1921. The machine had just been taken off the bus and, following the regular practice of testing the overspeed mechanism weekly, the unit had been gradually brought above its normal speed of 1,500 r.p.m. until the automatic governor operated at 9 per cent overspeed, when the throttle closed and the machine began to slow down. A few seconds after the main throttle had closed, shutting off the steam to the unit, a loud hissing noise was heard, instantly followed by two heavy crashes and a shower of broken pieces of metal, including the exciter armature with the end of the mainshaft. Fortunately, there were no serious injuries to any of the employees in the plant and comparatively little damage done to the building or other equipment. The general appearance of the turbine immediately after the accident is shown in Fig. 1, while Fig. 2 shows the appearance after the broken casings had been removed.

H. F. Moore, professor of engineering materials, University of Illinois, and George L. Kelley, metallurgist, of Philadelphia, were retained by the Philadelphia Electric Co. to investigate the cause of the failure, and it is from their reports that the present article is compiled.

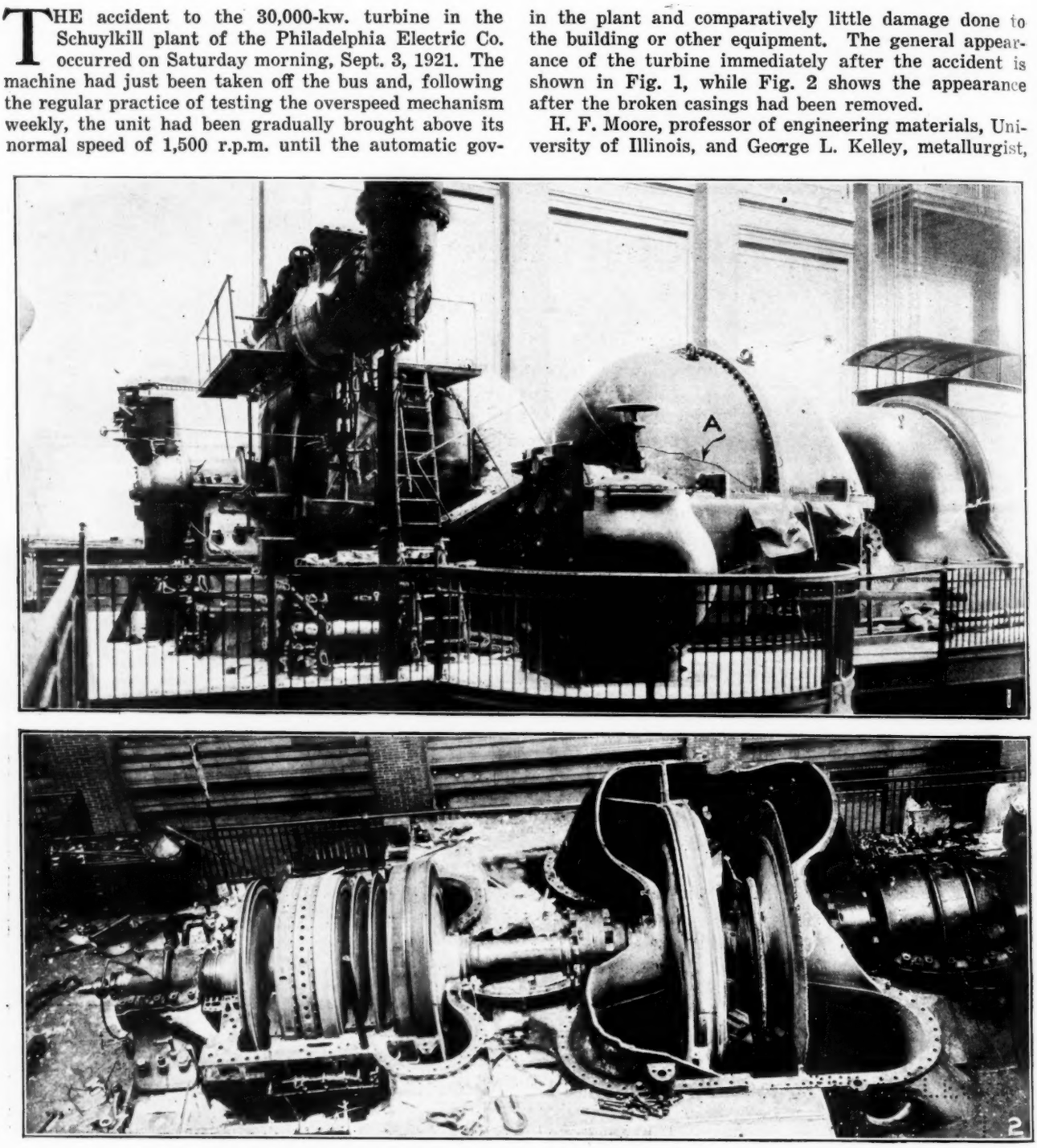



FIG. 1. THE TURBINE IMMEDIATELY AFTER THE FAILURE. FIG. 2 (BELOW) THE SAME AFTER THE REMOVAL OF THE CASINGS AND DEBRIS

The low-pressure casing was cracked as shown at *A* in Fig. 1 and rather worse on the opposite side. The steam passages from the high- to the low-pressure stages were broken. Two pieces were broken out of one of the discs in the low-pressure stages, as shown in

Figs. 2, 3, 4, 12 and 13. All the shaft bearings were broken and the 20-in. mainshaft was broken off short between the bearing *A*, Fig. 4, and the generator, the shorter section being shown in Fig. 6. Other fractures were apparently due to flying particles. The broken wheel was approximately 9 ft. diameter, and the pieces broken out were about 5 ft. long, ranging in width up to 22 in., and occurred about 38 in. apart on the periphery. One theory offered to explain the failure was that the initial fracture occurred in the north-side steam passage leading from the high-pressure to the low-pressure stages and originating in a defect noted in the fractured casting. When the wreck occurred, the low-pressure stages were under vacuum, and if the steam passage casting were fractured, a fragment might have been drawn inward, striking the blades of the turbine and starting the wreck.

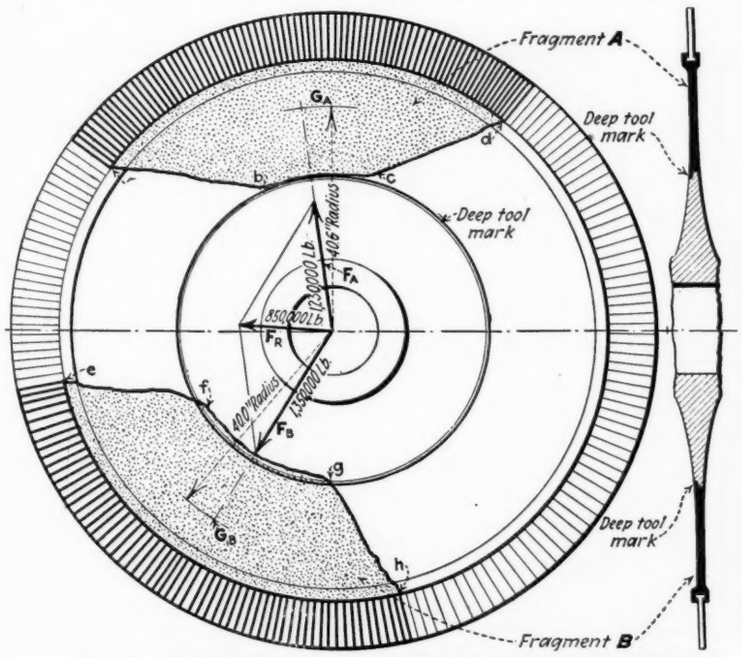



FIG. 3. DIAGRAM OF RUPTURED LOW-PRESSURE DISC

This does not seem probable to Professor Moore. Nearly, if not all, of the fragments broken from the casting were found outside as if they had been thrown outward. As he explains, under running conditions the passage is under a bursting pressure considerably greater in magnitude than the collapsing pressure existing when there is a vacuum in the passage. Moreover, the casting is designed with stiffening ribs on the outside, so that under bursting pressure the bulging of the passage will tend to cause the ribs to be in tension in their outer fibers and the plates to be in compression. Under vacuum this condition would be reversed. Cast iron is much weaker in tension than it is in compression, and under vacuum conditions the larger amount of metal in the plate would be in tension, and the tensile stress would be low. For two reasons, therefore, the amount of pressure and the favorable disposition of the metal, it would seem unlikely that the steam-passage casting would fail when the interior was under vacuum. On the other hand, the fractures in the two steam passages, one in the north-side passage and one in the south-side passage, may readily be explained as *secondary* failures. Both fractures are in line with the broken turbine disc in a position that formed a point blank target for flying fragments. Professor Moore included with his report three samples of steel broken in the laboratory. *A*, a very soft steel, broken at a sharp corner by the application of repeated bending load, is what is frequently called a "fatigue failure." This showed the two distinct areas characteristic of this mode of fracture, a smooth dull surface where the surfaces had worked against each other in the progressive development of a small crack and the bright rough surface of the new break. *B*, a sample, Fig. 5, from a small cold-rolled steel shaft, fractured at a sharp corner by a cross-bending load, shows the granular fracture all over the surface; *C*, a sample from a small cold-rolled steel shaft, fractured at a sharp shoulder under a twisting load, shows evidence of the dragging of one piece of the shaft

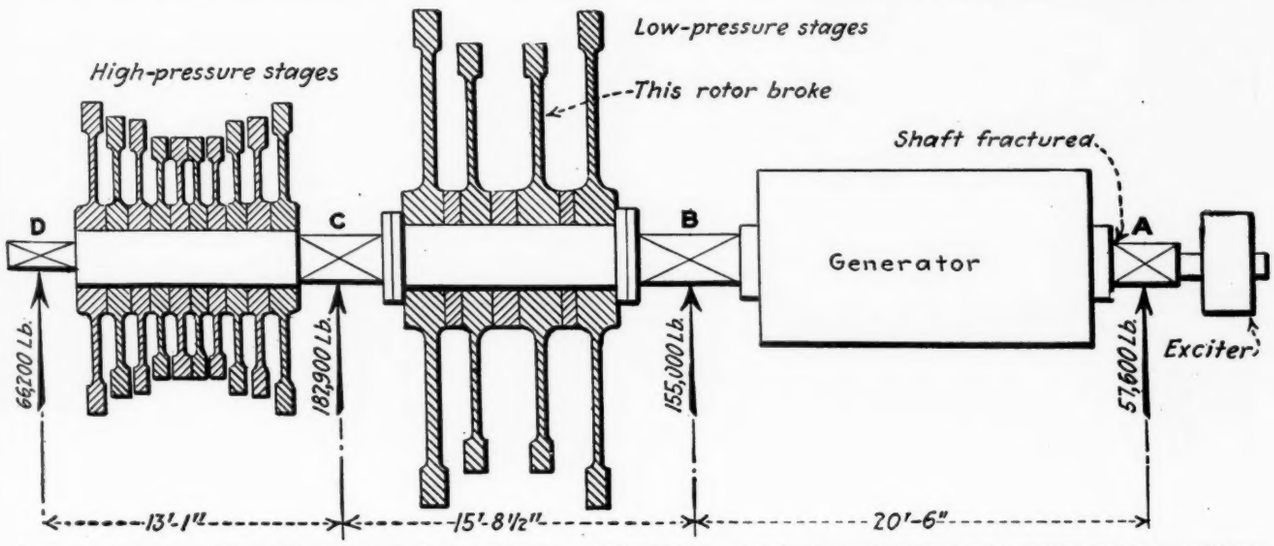



FIG. 4. OUTLINE OF ROTOR SHOWING RELATIVE LOCATION OF PARTS AND POINT OF FRACTURE OF 20-IN. SHAFT

over the other as fracture occurred. The fractures in the disc plainly show the progressive character of sample *A*. The old and new parts of the break are indicated in Fig. 13. They also show quite plainly in the photographs accompanying Dr. Kelley's report. An attempt to reproduce these is made in Fig. 12.

One of the most striking features of the wreck was the breaking of the mainshaft and the tearing up of the surface of the exciter armature. The piece shown in Fig. 6 *A*, carrying the overhung exciter armature and commutator broke off just inside the bearing *A* in Fig. 4. A photograph of the generator with its end of the broken shaft is reproduced in Fig. 10, and on a larger scale in Fig. 5-A. The resemblance between this fracture and that of Professor Moore's sample *B*, broken at a sharp corner by a cross-bending blow, is striking. Both show at one edge a small beveled area with a finer-grained surface than the main area of the fracture.

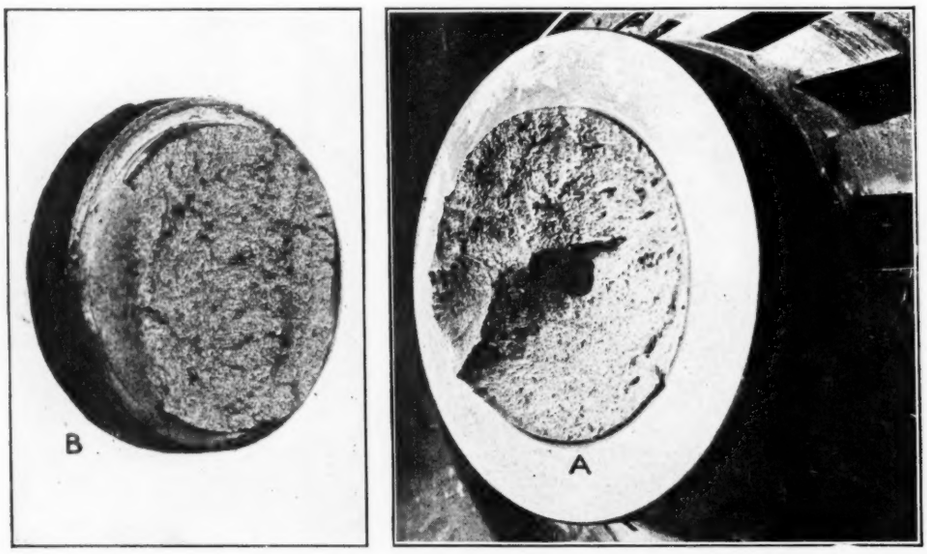
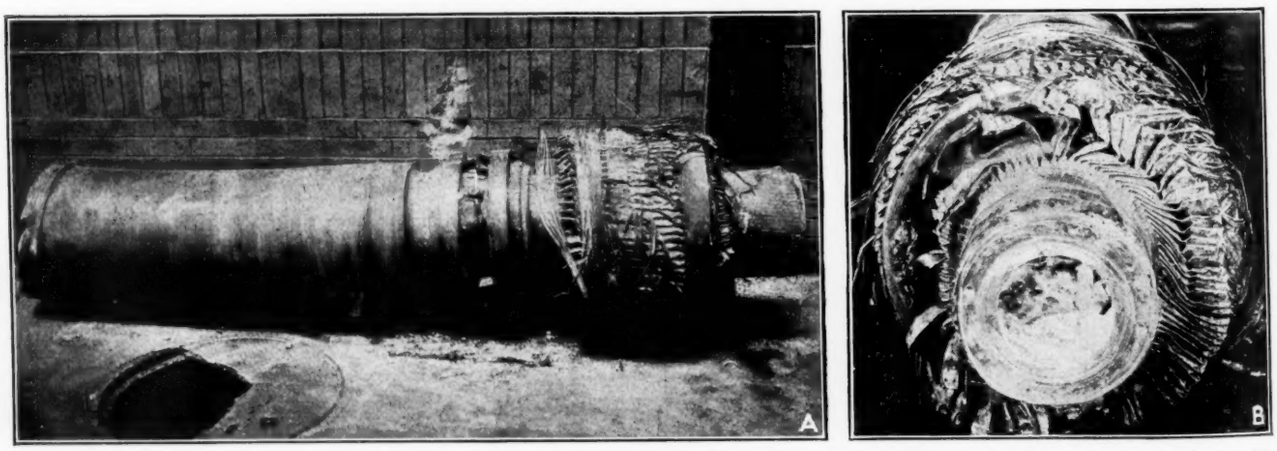



FIG. 5. COMPARISON OF FRACTURE OF ACTUAL SHAFT *A* WITH EXPERIMENTAL FRACTURE *B*

Another theory of the primary cause of failure held that a polepiece of the exciter field became loose and was jammed into the armature, causing enough twisting or bending to break off the exciter frame and the mainshaft, throwing the remainder of the shaft so out of line that the wreck of the turbine disc and of the bearing followed. A loose polepiece on the exciter field would, Professor Moore says, in all probability set up twisting action in the shaft and the field-magnet frame. The air gap of the exciter was small, and before much bending could occur, the armature would be forced against the polepiece opposite to the loose polepiece, and the abrasion of the armature surface due to the gripping action of the polepieces should be evident on opposite sides of the armature. Fig. 6-B shows the armature after the wreck and shows one side badly abraded, while the other side is but little abraded. The marks of the polepiece which came in contact with the armature are on one side only. This seems to show that there occurred a bending of the shaft from some cause, with a consequent jamming of one side of the armature of the exciter against the polepieces and a violent bending action on the field framework and the shaft. The failure of the shaft seems to be most probably a secondary failure caused by the bending of the shaft from some other cause than trouble in the exciter.

The evidence seems, to Professor Moore, to show that the failure of the mainshaft was one of the last events in the wreck. "When the shaft failed," he says, "the main generator field was left as a weight of about 50 tons overhanging the bearing *B* in Fig. 4, which is a diagram of the turbo-generator rotor. This heavy overhung weight was badly out of center, therefore it would seem highly probable that if, under these conditions, rotation was kept up even for a few seconds, this heavy eccentric weight would have been thrown against the armature windings of the generator, tearing them loose. Except at one end, where the blades of a small ventilating fan stripped off some insulation, the generator armature windings are uninjured. It seems to the




FIGS. 6A AND B. BROKEN-OFF SECTION OF MAINSHAFT WITH EXCITER ARMATURE AND COMMUTATOR ATTACHED

writer that the breaking of the mainshaft must have been about the *last* event in the wreck."

It has been pointed out (still quoting Professor Moore) that both fractures in the turbine disc showed evidence of a progressive fracture originating in a deep tool mark and extending almost through the thickness of the disc, together with a final sudden fracture resulting from the sudden tearing out of fragments *A* and *B* (Fig. 3) from the disc after it had been sufficiently weakened by the spread of the progressive fracture. The cause of such a fracture must be sought in the existence of lateral vibrations in the disc. The steam jet enters on one side of the buckets and leaves from the opposite side, any frictional lateral drag from the steam is all in one direction, and as the disc revolves the steam must strike on any given blade with a regular rhythmical variation of force. At certain speeds this rhythmical variation might be so nearly "in tune" with a natural period of lateral vibration for the disc that severe repeated bending stresses would be set up. If such a critical speed existed between a state of rest and the normal speed of the turbine, the disc would pass through a brief period of severe sidewise bending stress every time the turbine was started, and perhaps every time it was stopped. If for a period of one second the turbine speed was sufficiently near the critical speed to cause severe lateral vibration, it would be subjected to, perhaps, 100 severe lateral stresses. The turbine was usually stopped and started every two days and had been in service for about seven years. It seems probable that the disc may have been subjected to as many as 100,000 repetitions of severe lateral vibration—a sufficient number to develop such a typical progressive fracture as was shown.

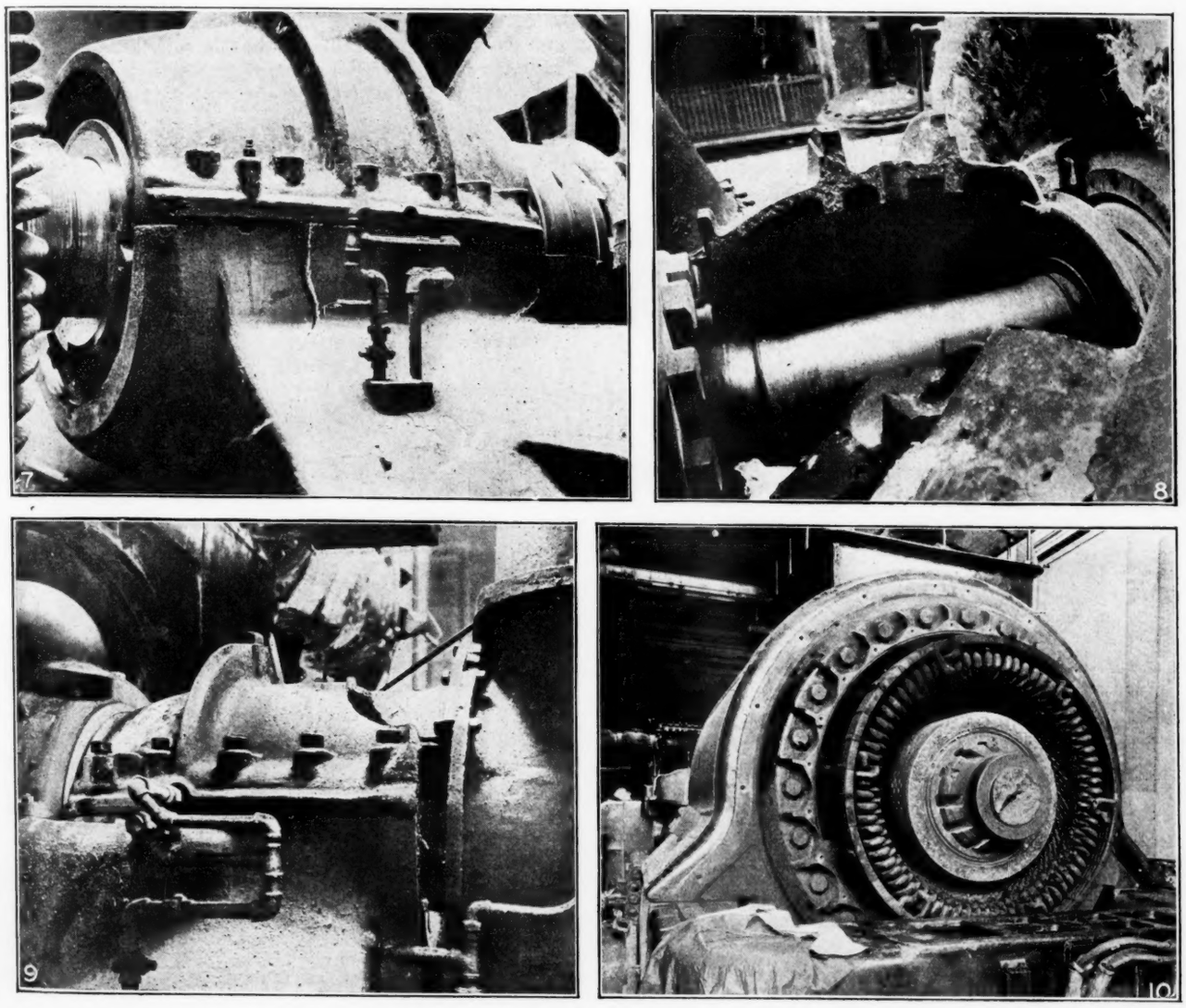


FIG. 7. BEARING *B*. FIG. 8. BEARING *C*. FIG. 9. BEARING *D* AS LOCATED IN FIG. 4. FIG. 10. GENERATOR WITH END OF BROKEN SHAFT

It may be noted that probably any dangerous lateral vibration in the disc was a rather complex process. If the disc in sidewise vibration took a simple sidewise curve, as shown in Fig. 11 (*a*), the blades of the turbine would hit the nozzles, or the edge of the disc would hit a diaphragm before sufficient deflection took place to set up serious bending stresses or, to put it in another way, with a one-lobe vibration, as shown in Fig. 11, (*a*) $R_1$, the radius of curvature of the bent center line of the disc, would be large and the fiber stress low. If, however, the disc vibrated in several "lobes," as shown in Fig. 11 (*b*), a considerable fiber stress could be set

up with a small lateral vibration of the edge of the disc. For this case $R_2$, the radius of curvature of the bent center line, would be much smaller than $R_1$ in Fig. 11 (*a*), and the fiber stress would be higher.

The rough surface finish and the deep tool mark previously noted doubtless served to localize fracture due to any sidewise vibration. Judging from recent tests at the University of Illinois, made in the course of the Joint Investigation of the Fatigue of Metals, such surface conditions might reduce the ability of the disc to resist lateral vibration by as much as 20 per cent.

A progressive fracture having started, it might be expected to spread until the disc was so weakened that, under the steady centrifugal force due to rotation, a fragment would suddenly tear itself loose, the final failure being a sudden shearing or tearing of the metal not destroyed by progressive failure.

From measurements and graphical calculations the weights of the fragments *A* and *B* (Fig. 3) were found to be 410 lb. for fragment *A* and 455 lb. for fragment *B*. The distance from the axis of the mainshaft to the

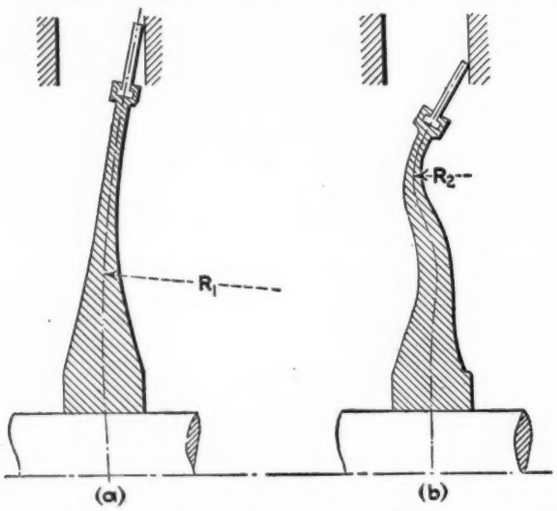



FIG. 11. SHOWING POSSIBLE MAGNIFICATION OF STRESS BY MULTIPLE-LOBE VIBRATION

centers of gravity of the fragments was found to be 3.39 ft. for fragment *A* and 3.33 ft. for fragment *B*, which at the normal speed of 1,500 r.p.m. would give a centrifugal force to the fragment *A* of 1,230,000 lb. and for the fragment *B* 1,350,000 lb.

If the primary cause of the wreck was a progressive failure in the turbine disc, then, when that progressive failure had gone far enough to allow the centrifugal force to tear out a fragment, the metal from *f* to *g* (Fig. 3) was cracked nearly through the disc. For fragment *B* the lines of final failure are nearly radial, and an approximate idea of the average stress set up may be obtained by dividing the centrifugal force by the area of the metal along *ef* and *gh*. This area, by measurement of careful sketches made from measurements of the fragment is about 36 sq.in. and the average shearing stress is $\frac{1,350,000}{36} = 37,400$ pounds per square inch.

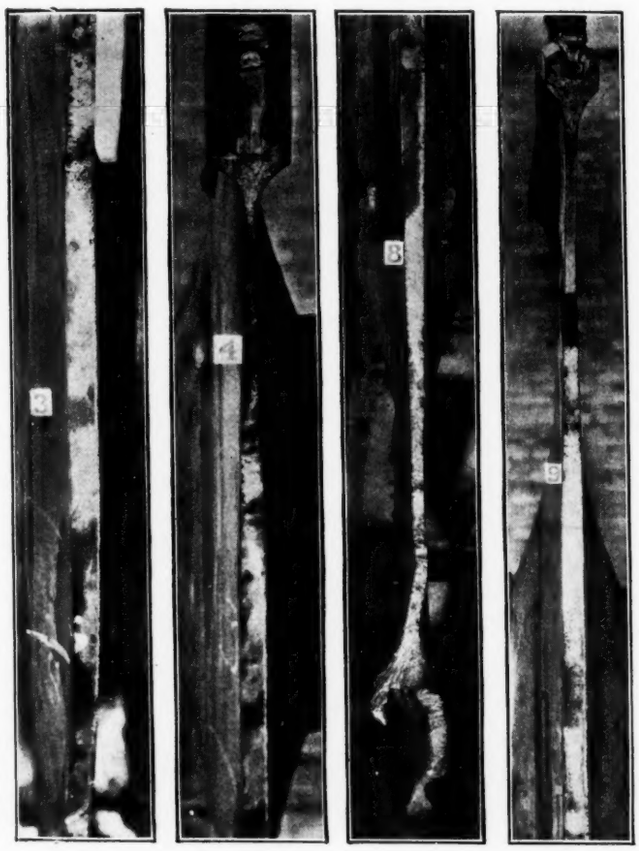
By analogy with the distribution of shearing stress in beams the shearing stress at the middle of the fracture may be expected to be not less than 50 per cent in excess of the average, or 56,000 lb. per sq.in. This is well above the yield point in shear for 3.5 per cent nickel steel, as found by Seely and Putnam in Bulletin 115 of the Engineering Experiment Station of the University of Illinois and, in view of the probable irregularity of stress distribution over the fracture, is believed to indicate a stress sufficiently high to tear out the fragment.

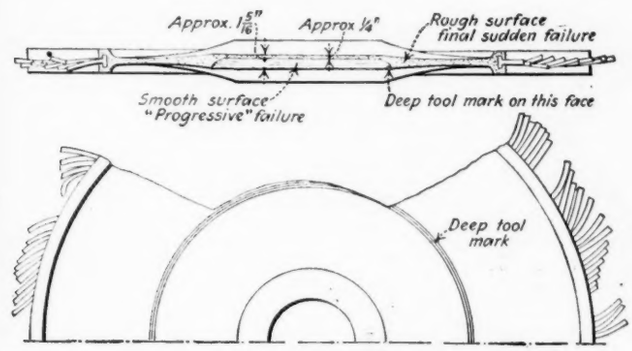
If the primary cause of the wreck were a progressive failure in the disc, then the wreck might be expected to occur at one of the regular periods of high speed. When, in order to try out the automatic stop, the speed was increased to 109 per cent of its normal magnitude, the centrifugal force was increased to 1.19 times its normal value. This is a very material increase in the stress and would seem to indicate that if a turbine is ever in danger of wreck from a progressive failure in a disc, it is at the time when, for any reason, the speed is increased.

If the primary failure was in the turbine disc, then the other failures can readily be explained. The first effect of the primary break might well be to crack the casing as shown in Fig. 1, which would allow an inrush of air into the vacuum within the casing and would cause the loud hissing noise noticed during the wreck. The flying off of the fragments would batter and tear nozzles and diaphragms and would throw the pieces against the walls of the steam passages, fracturing those walls. If fragment *B* broke out first, then the rotating parts would be unbalanced by 1,350,000 lb., and after both fragments broke off, the unbalanced forces would be the resultant of the centrifugal forces of the two fragments, which resultant is graphically determined in Fig. 3 and found to be 850,000 lb. That is, there would be a lateral force of from 850,000 lb. to 1,350,000 lb. acting on the shaft. Any exact computations for secondary events are quite out of the question, the action being complicated by the interference of broken fragments, the inertia and the gyroscopic action of heavy rotating masses, and the magnetic forces of the field of the generator. In a general way the writer (Mr. Moore) pictures the course of events as follows: The enormous lateral force first broke bearing *B* (Fig. 4) downward (see Fig. 7, which shows bearing *B* after the wreck). This failure caused the rotating field to run out of true and the exciter end of the mainshaft to bend near bearing *A*, which is spherical-seated. This jammed the exciter armature into the polepieces, bending and breaking off the shaft and throwing it to one side, together with pieces of the exciter frame and bearing *A*. This apparently stopped the rotation of the shaft, discs and generator field. During this action there was sufficient racking action on the shaft to break up bearing *C* badly and bearing *D* slightly. Fig. 8 shows the condition of bearing *C* after the wreck, and Fig. 9 shows the condition of bearing *D*. There seemed to be a general tendency for the rotating parts to move toward the exciter end of the generator.

The photographs of fracture reproduced in Fig. 12 accompany Dr. Kelley's report, and the sketch, Fig. 13, is after Professor Moore. Dr. Kelley says: "These fractures were on the portion of the bucket wheel that was still in place on the shaft. Immediately below the rim and for some inches beyond, evidences of dendritic structure were clearly discernible. This indicates that the wheel was probably made from cast steel in distinction to forged steel. It also indicates that the original cast structure had not been effectively destroyed by heat treatment. As the center of the wheel is approached, the dendritic structure disappears and for a length of about 25 in. both fractures present a very smooth surface, having the characteristics of hard metal.

Two test pieces were taken in a tangential direction from one of the larger fragments at distances of 12 and 20 in. from the periphery of the wheel. The latter position is within about one inch of the metal which appears hard. The test results indicate that there is no difference in hardness in the two positions. This smooth fracture somewhat suggests the appearance of a detailed or progressive fracture, but no evidence of the rubbing of crystals was noted nor could any flaw be located which could have initiated the fracture. It seems improbable that these are progressive fractures






FIGS. 12 AND 13. REPRODUCTIONS OF PHOTOGRAPHS OF FRACTURES IN DISC WITH SKETCH SHOWING LOCATION OF OLD AND NEW FRACTURES

because of the large area and because there are two similar fractures on opposite sides of the wheel."

Dr. Kelley's discussion of the cause of the failure is as follows:

The casing exhibited no particularly striking characteristics. It is said to have shown distinct evidences of growth during the six years in which it was in use, but this is in all respects a normal phenomenon and of necessity slow at the relatively low temperatures involved.

a. The first abnormal occurrence noted in connection with the failure was a hissing sound. This was followed so closely by the breaking of a 6-in. steam line and the bursting of the turbine that the sequence of events could not be followed. It is possible that the casing was the first thing to yield and that the hissing sound was due to the relief of the 24-in. vacuum. Parts of the casing falling on the turbine wheel might have caused this to break, after which the turbo-generator shaft broke.

b. The failure of a bucket followed by jamming between the wheel, and the casing may have been a cause.

c. The bucket wheel may have broken. No evidence of failure was noted which could be attributed either to the quality of metal used or to the method of machining. Present practice involves the use of forged steel instead of cast steel, and all are heat-treated by quenching and drawing instead of by annealing. This latter process gives a bucket wheel having moderately high physical properties and one that is much less subject to failure from fatigue stresses.

d. The shaft may have broken. While this is a possibility, it is much more probable that the failure occurred from one of the three possible causes given above. The condition of the fracture indicated fair commercial practice in forging and annealing, and no features were noted that would indicate that this piece was the primary cause of the trouble.

e. I have not been able to reach a definite conclusion as to the cause of the failure, but it seems likely to me that the possibilities suggested in paragraphs b and c are the more probable ones.

It is now the practice of the General Electric Co. to specify that turbine bucket wheels for all the larger turbines and many of the smaller ones shall be forged and then heat-treated by annealing, quenching and drawing. A second quenching is used by some manufacturers and possibly by all. The likelihood that this would have a beneficial effect on the structure of the steel would, in my opinion, justify its specification in all cases. I believe the use of cast turbine bucket wheels has been abandoned. Because of the shape of these wheels some security would be gained if all bucket wheels were tested at more than two points to insure uniformity in properties. The General Electric Co. has had such a plan under consideration and at present may have it in use.

In design, abrupt changes of section and the formation of sharp angles in bucket wheels should be avoided as far as possible. The design of the rim still offers opportunity for improvement in this respect. I have reference to sharp angles in the groove.

As to the selection of material to be used, physical properties required and method of heat treatment, no better practice than the present one occurs to me. As suggested above, a more rigorous testing may be justified.

I am aware that the General Electric Co. has taken pains to leave machined surfaces free from sharp corners. It is important that this caution be maintained, for such points may serve as a locus of weakness resulting in fracture.

# Three Kinds of Corliss Valve Gears

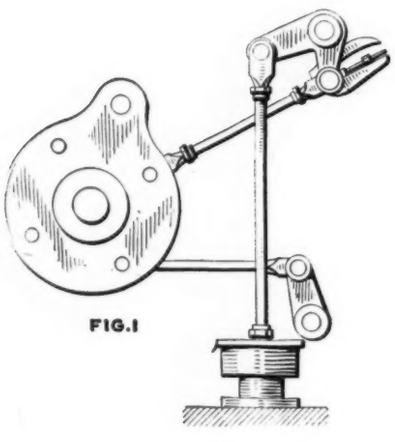
By W. H. WAKEMAN

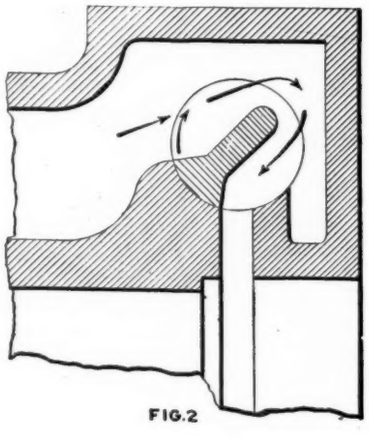
DIRECTIONS for setting Corliss valves do not always take into consideration the fact that there are several kinds of gears and valves to be adjusted, hence one rule cannot apply to all of them. A comparison of these should prove instructive.

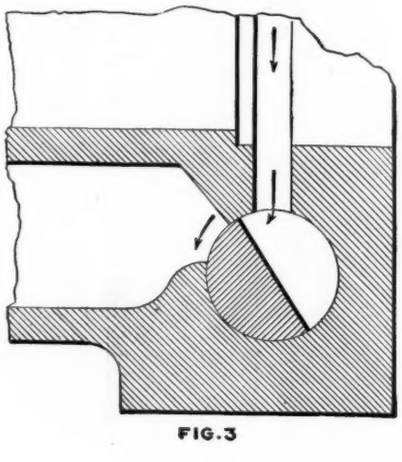
The term "travels inward" is used to designate a valve that moves toward the center of the cylinder to open. "Travels outward" means that it moves toward the end of the cylinder to open.

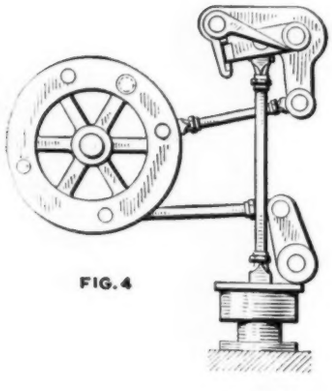
Fig. 1 illustrates a type of gear that I operated for several years and found satisfactory, as it could be accurately adjusted, was not very noisy and proved durable in practice. The steam valve travels inward as shown in Fig. 2, and the exhaust valve moves in the same direction, Fig. 3. It is sometimes claimed that such a steam valve operates to a disadvantage because the steam must travel around it to reach the port and this causes a reduction of initial pressure in the cylinder. There are exceptions to this rule, as indicator diagrams taken from one engine of this kind that I had charge of, showed an initial pressure only three pounds less than boiler pressure, and the steam pipe was about 75 ft. long. These diagrams showed that while the steam was expanded to about five pounds gage pressure, it was not released until the crank was on the center. It could be released sooner by shortening the connection between the jim crank and the wristplate, but it also reduced the compression pressure on the return stroke more than was desired. Such a late release tends to the development of full power, but this is offset by high back pressure early in the return stroke.

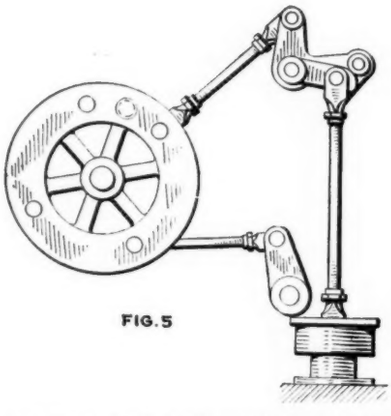
Fig. 4 is a gear that is extensively used with good results. While its appearance is quite different, it operates the valves the same as that shown by Fig. 1. In both instances the crank has just passed the center nearest the wristplate, so that the steam valves are in the act of opening, and the exhaust valves are closing.

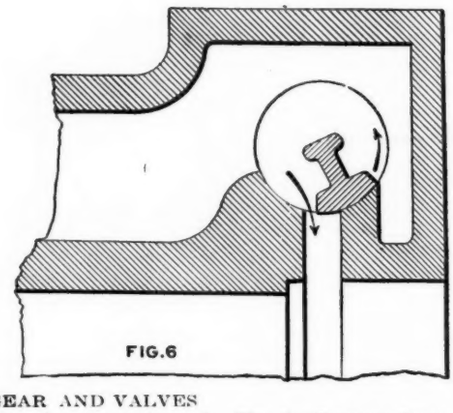



FIGS. 1 TO 6. TYPES OF CORLISS-ENGINE VALVE GEAR AND VALVES

Fig. 1—Old type of valve gear. Fig. 2—Steam valve travels inward. Fig. 3—Exhaust valve moves inward. Fig. 4—Common type of valve gear. Fig. 5—Another common design of valve gear. Fig. 6—Steam valve travels outward.

In Fig. 5 the steam valve is opened by a different design of crank but the exhaust-valve connections are the same. The steam valve travels outward in this case, as illustrated in Fig. 6. This gives a more direct passage for the steam, which may be an improvement where the engine has a high piston speed. The exhaust valve travels inward as shown in Fig. 3.

The foregoing gears require the eccentric to be set 90 deg. in advance of the crank, plus whatever is required by the lap of the valves, but Fig. 7 illustrates a gear in which the eccentric follows the crank. It would be 90 deg. behind it if the lap of the valves were not considered, but in order to make due allowance and give the required lead, the eccentric must be moved in the direction of rotation. The result is that it must

have what may properly be called "negative angular advance."

The steam valve travels outward (Fig. 6) and the exhaust valve travels inward (Fig. 8).

This design brings the eccentric exactly opposite the point due to the gears shown in Figs. 1, 4, and 5, provided valves have the same lap and are given equal lead. This differs from what is found when the direction of rotation of an engine is to be reversed. It is not difficult to state that this requires the eccentric to be set exactly opposite to its former position, but unfortunately, this is true only when the valves have no lap and no lead is wanted, which is seldom if ever found in practice. This is illustrated in Fig. 9, in which the upper eccentric is in the correct position for running "over" and the lower is right for the "under" direction. To avoid misunderstanding, it may be well to state that the former is when the top of the flywheel moves from the cylinder, and the latter is when it travels toward the cylinder.

Suppose an engine has been running "under" and it is desired to reverse it permanently. Fig. 9 demonstrates that the eccentric should be moved in the direction that the engine is to run, because the distance is less than if it is moved in the opposite direction. Sometimes it is difficult to move an eccentric after it has been in service several years, hence the saving in the amount of movement when changing its position becomes an important item.

Theoretically, it may be stated as follows: To move an eccentric from a position which is 90 deg. in advance of the crank, to a place directly opposite, makes it necessary to turn it through 180 deg. Assume that it requires an angular advance of 10 deg. in both the old and the new positions. To move it in the opposite direction calls for $180 + (2 \times 10) = 200$ deg. If it is moved in the same direction, it will travel $180 - (2 \times 10) = 160$ degrees.

On attempting to start a cross-compound Corliss engine, the engineer found that it would not carry the usual load because of a slipped eccentric. If he had understood the principles mentioned in this article, the cause of the trouble could have been removed in a short time, but as he did not, he could not decide what was required. After a portion of the works had been shut down for several hours, an expert was called in, who put the eccentric back where it belonged, thus giving the engine full power again.

When an engine is fitted with two wristplates, one for the steam and the other for the exhaust valves, if the design causes them to travel in opposite directions, it presents an element of danger to the oiler, as it is likely to cause accidents to thumb and fingers, for these gears must be oiled when in motion. For illustration, if the steam valves are driven as shown in Fig. 7, that eccentric is behind the crank, with the valve shown in Fig. 6. Driving the exhaust valve shown in Fig. 8 by the gear in Fig. 4 brings that eccentric in advance of the crank, therefore they will travel in opposite directions. If the steam gear in Fig. 5 drives the valves in Fig. 6 and the exhaust connection drives Fig. 8, the wristplates will move nearly together.

Fig. 10 shows an exhaust connection with the jim crank in full lines, in a central position; its travel in

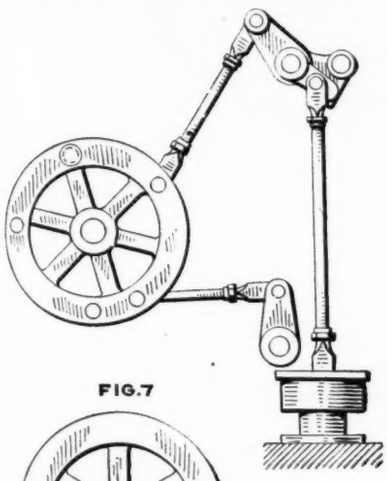


FIG.7

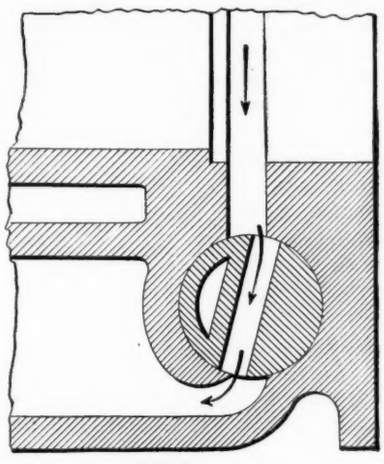


FIG.8

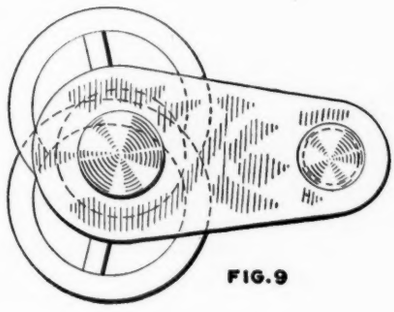


FIG.9

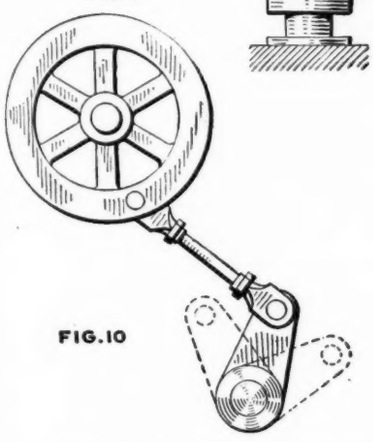


FIG.10

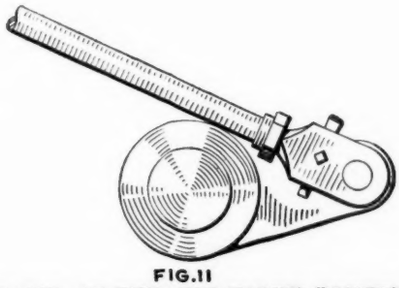


FIG.11

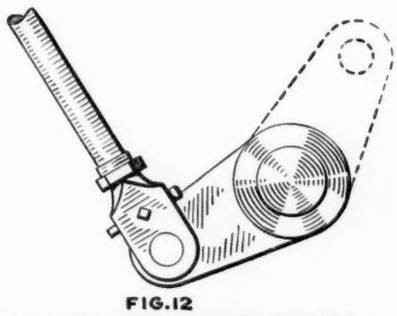


FIG.12

FIGS. 7 TO 12. VALVE GEARS, TRAVEL OF EXHAUST VALVE, POSITION OF ECCENTRICS AND JIM CRANKS

Fig. 7—A gear requiring eccentric set 90 deg. in advance of the crank plus that required by lap of the valve. Fig. 8—Exhaust valve traveling inward. Fig. 9—Showing positions of eccentric when engine is to be reversed. Fig. 10—Showing travel of jim crank. Fig. 11—Exhaust connection too long. Fig. 12—Exhaust valve turned with jim crank in non-operating position.

either direction appears in the dotted lines. When making changes in these gears, in efforts to secure better results, these limits of travel should not be greatly exceeded. Fig. 11 shows a connection that is too long, as it carries the jim crank farther forward than it was designed to go, thus causing the connection to be bent in the operation.

Some of these gears are designed so that the jim crank can make a complete revolution without bending or breaking anything. In Fig. 12 the dotted lines show the normal position of this crank (when the wristplate is in the center of its travel), but one morning while warming the cylinder, the engineer threw the wristplate too far over, thus bringing the jim crank into the position shown by the full lines. This turned the valve over so that there was practically a full port opening to the exhaust chest. The fireman could not keep up steam to run it, and the engine would not develop enough power to run the machinery.

The engineer in charge could not decide on the proper remedy, hence it was necessary to send for an expert, who located the cause of trouble and quickly turned the jim crank upward to its proper position. Such a mishap will rob an engineer of more prestige than he can regain in several years, and the necessity of calling in outside assistance is a sure indication of his lack of knowledge of the design, adjustment and operation of these valve gears.

In another plant a Corliss engine suddenly failed to carry its usual load. The engineer could not locate the cause of failure during the day; at night an expert was engaged to find it. He found the valve gear properly adjusted, and after a long search and many experiments, discovered that one of the exhaust stems was twisted, hence the valve was open when it should have been closed. The wristplate was placed in its central position, and the valve located in its corresponding place. A new spline was cut in the stem, and when the key was driven into it, the trouble disappeared.

## Coppus "Vano" Blower

The Coppus "Vano" blower, Fig. 1, is of the screw-blade propeller type that delivers the air in the same direction as it enters. It operates against pressures

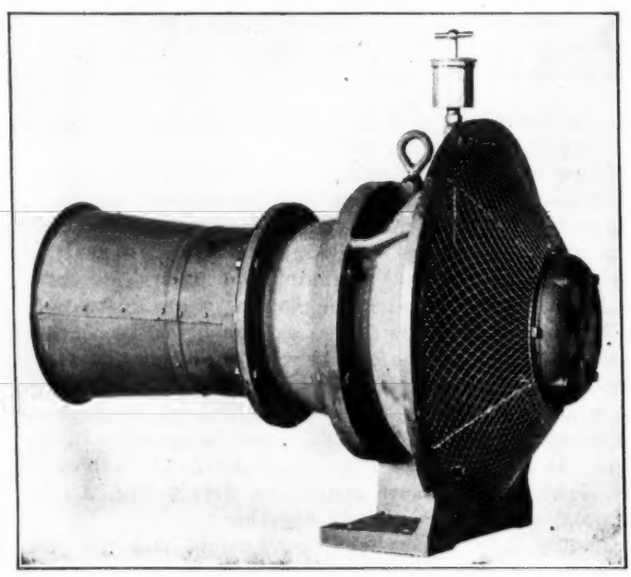


FIG. 1. NEW COPPUS "VANO" BLOWER

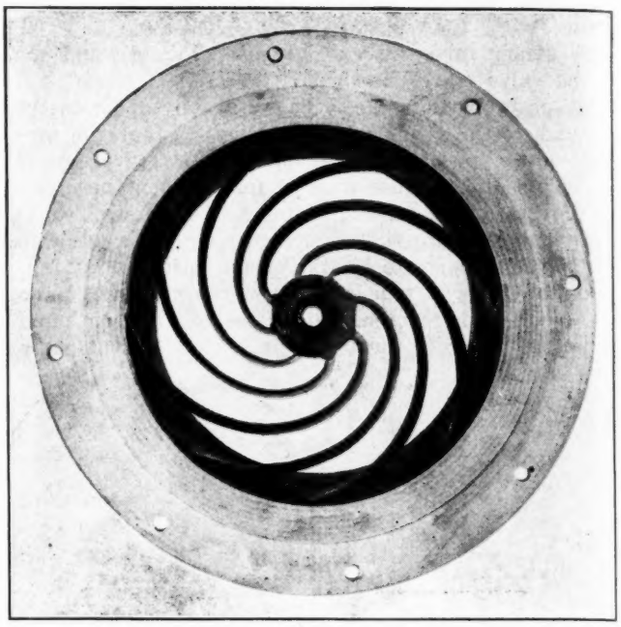


FIG. 2. STATIONARY GUIDE VANES

up to 8 in. of water and can be employed where, until now, only centrifugal blowers could be used; its efficiency runs up to 80 per cent for both high- and low-pressures, and the power consumption at constant speed is practically unaffected by variations in air delivery or pressure.

The principal feature of the blower is the stationary guide vane beyond the propeller, Fig. 2. The air current leaving the propeller is radially subdivided by the individual guide-vane blades and taken up by them without shock. The guide-vane blades, which have a curvature increasing in the direction of the rotation of the propeller, concentrate the air current and give it a further acceleration inside of the stationary guide vane, so that a considerable part of the pressure is produced in the latter. A large part of the end thrust is thus taken up by the stationary guide-vane casing. The air streams, into which the flow of air has been subdivided by the guide-vane blades, leave the guide-vane casing, on account of the kinetic energy, slightly rotating and convergent toward the axis, so that the smallest section of the air flow is reached beyond the guide-vane casing.

On account of the three principal features enumerated, the blower is adapted to such uses as undergrate or forced draft for hand-fired boilers, chain-grate, overfeed and underfeed stokers, induced draft, main and individual room or tunnel ventilation for mines, air heating and drying installations, cooling of electric motors and generators, ventilation of factories, boiler rooms, ships, tunnels, etc.

The blower is a high-speed machine, which requires a comparatively small driving unit, and owing to the compactness of design it can readily be installed in pipe lines, a distinct advantage in ventilating, heating and drying systems.

The blower, which is manufactured by the Coppus Engineering and Equipment Co., Worcester, Mass., allows of reversing the direction of rotation, which changes the direction of the flow of air through the blower. In such a case it delivers from one-third to one-half its normal capacity.

# Induction-Motor Slip-Ring and Brush Troubles and How To Remedy Them

By JAMES FOX

FROM time to time serious troubles are experienced with the slip rings and brushes on induction motors. Considering the vast number of these machines that are operating successfully, the number of these cases is practically a negligible quantity, the ratio of successful machines to those in which trouble develops being so large as to be a good argument that

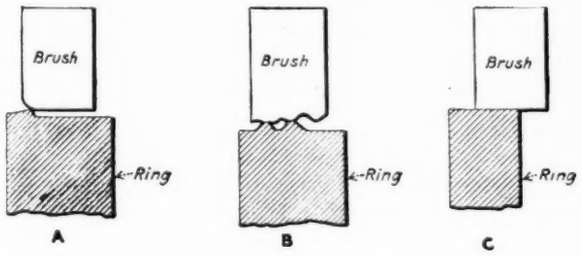



FIG. 1. RESULTS DUE TO END PLAY AND IMPERFECT SETTINGS

the troubles are not always due to inherent faults in the machines themselves.

From observations made in the field it has been found that comparatively few know very much about the facts conducive to first-class brush and ring operation. Those who do are to be found mostly in the employ of the larger power-generating companies or of large industrial corporations where the various operators have been instructed by trained technical men. More often brush and ring troubles develop in the small industrial power plants where the electrical equipment is considered more or less secondary to production at minimum cost, or where the operator knows little about the fundamentals of the apparatus in his charge. What is to be thought of an industrial concern who pays an electrician $75 per month to take charge of the entire electrical equipment representing a total investment of over half a million dollars, and then complains to the manufacturer of that apparatus because it has become nothing but a source of trouble?

Another instance is the case of an owner of a large mill who wired, telephoned and finally threatened suit because his new motor would not start up the mill; that he was being put to untold expense by losing production, and that the local electrical specialists who had worked on the job were positive the motor was all wrong and never could have been tested before it left the factory, and then it is suddenly discovered that the electrician had forgotten to put in the slip-ring brushes. This perhaps is not quite so bad as the man who bought a 100-hp. 60 per cent power-factor slip-ring motor and expected it to operate successfully from a transmission line three miles long, fed by a 115-kw. 80 per cent power-factor generator.

These are a few cases in point which actually happened. Perhaps they are somewhat apart from brush and slip-ring troubles, but they tend to show the almost unbelievable things that are actually happening in these enlightened days and indicate that the source of trouble is often traceable to some unseen fundamental condition far removed from the visible points of distress.

There are three fundamental points and other factors that must be observed if satisfactory brush and slip-ring operation is to be obtained.

1. The slip ring must run true, be free of grooves or pits and have a clean, smooth surface.

2. The brushes must make their full contact area with the surface of the ring and have free movement in the body of the holder.

3. The spring tension should be adjusted, preferably by a spring scale, between the limits of 2 to 3 lb. per sq.in. of contact area between the brush and the slip ring.

Among other things worthy of notice the brush pigtails must make good contact, not only with the brush, but also at the point where they are connected with the holder, brush stud or whatever means are employed to carry the current away from the motor. Where feasible, brushes or brush-holders on the same ring should be staggered.

In cases where motors are assembled in the field by the purchaser, special care must be observed to assemble the brush rigging in exact accordance with the drawings furnished with the job and to be sure that there is no interference of pigtails between adjacent rings.

The use of a lubricant on the slip rings should be discouraged. In general it tends to create imperfect contact and the gumming up of the brushes so that

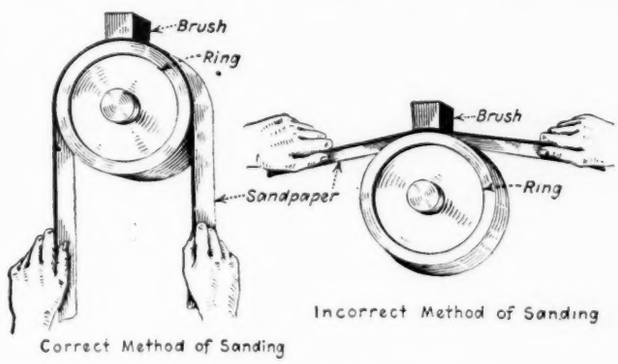



FIG. 2. "SANDING IN" BRUSHES

they will not work freely in the holders. The brushes as furnished usually contain enough lubricant to take care of this feature.

If trouble with rings and brushes once starts and is not taken care of, the trouble will gradually develop and become worse. If one or two conditions are corrected, operation will probably not be improved. All conditions must be corrected before satisfactory operation can be expected.

Action due to end play or the resetting of the brushes on a grooved ring is indicated by *A* and *B* and imperfect setting by cut *C*, Fig. 1. Proper "sanding in" brushes is more or less of an art and should be done by one experienced in this kind of work. The roughing

in may be done with coarse sandpaper, but the finishing should be done with a very fine grade. Fig. 2 shows the correct and incorrect methods of doing this work. Even with care exhibited in the manner indicated as correct, results such as shown in Fig. 4 may be obtained due to looseness of the brushes in the holders, or by forcing the sandpaper. For this reason all such work should be checked carefully. By giving careful attention to these details, serious and sometimes costly trouble may be avoided. It is always easier to prevent rapid wear of brushes and rings before they get into bad shape, than to stop it after once started.

There are many operators who never heard of the "sanding in" of brushes, of contact areas or of spring tensions; the latter should be measured as in Fig. 3

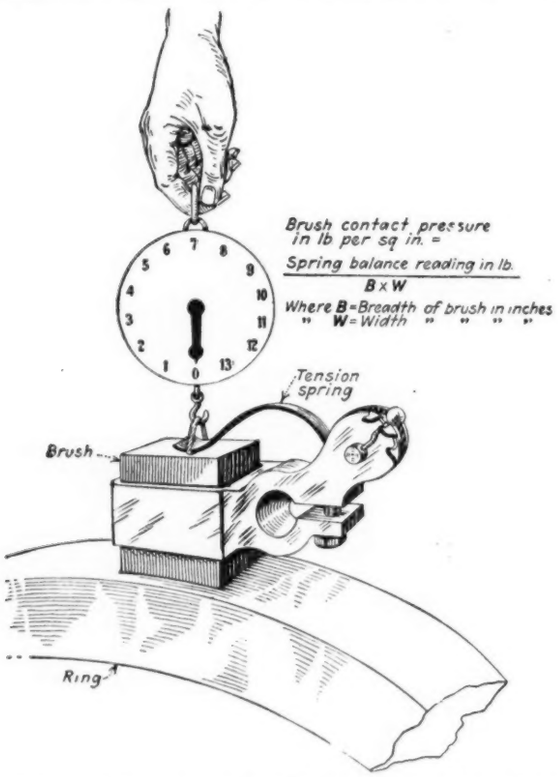

Brush contact pressure in lb per sq in. =
Spring balance reading in lb.
B x W
Where B=Breadth of brush in inches
" W=Width " " " "
Tension spring
Brush
Ring

FIG. 3. MEASURING BRUSH-CONTACT AREA AND SPRING TENSION

Flagrant cases of trouble have occurred where brushes were never fitted to the rings at all, where brush-contact pressures on the same ring varied from zero to 6 and 7 lb. per sq.in. and where the swabbing of rings with steam-cylinder oil was considered standard practice. Oftentimes collections of dirt and foreign matter or surface wear from the brushes and the rings themselves are allowed to accumulate in and around the rings, thus ultimately lessening the creepage distances between them and resulting in grounds or short-circuits between the various members.

In the building and application of motors, the manufacturer of the electrical apparatus differentiates considerably between the different kinds of motors and the various applications. Such things as hardness, strength, conductivity, densities, ventilation, resistance, etc., of both brushes and ring materials are given serious consideration. High-speed motors usually have different kinds of brushes and slip rings of different composition from slow-speed motors. The brushes of the high-speed motors are worked at entirely different densities from those of the slow-speed motor. Again, motors for use in connection with highly fluctuating loads may have rings and brushes considered specially applicable to this particular kind of service. All in all, the manufacturer endeavors to make motors as "foolproof" as possible, and has done so out of the experience gained not only

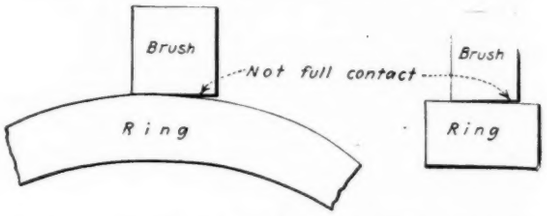


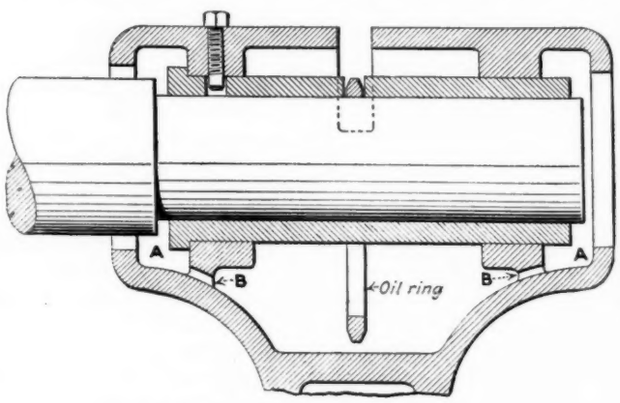

FIG. 4. RESULTS FROM INCORRECT SANDING

in the field, but by working in collaboration with the brush makers in conducting numerous and exhaustive laboratory and field tests.

## Stopped-Up Oil Passages Cause Leaky Bearings

BY B. A. BRIGGS

Not infrequently, trouble is experienced with oil leaking out of motor bearings, which if not remedied may result in badly worn or burned-out bearings. This trouble is found chiefly in bearings that have a small passageway for the oil to return from the end of the bearing to the oil well. In the bearing shown in the figure, the oil is carried by the rings up onto the shaft and flows down through the oilways and out between the shaft and bearing and is discharged at each end into the housing at *A* and *A*. From here it flows through the oil passages *B* and *B* into the well. If these passages are small there is always danger of their being stopped up with dirt, and instead of the oil flowing back into the well, *A* fills up and runs over to the outside. It is surprising how quickly the oil can be emptied out of a bearing when one of the passages is filled up. I have known cases where the bearings were filled up one day, and the next day the rings would be jingling away just as though the bearings had not been oiled for




SECTION THROUGH BEARING

months. In bearings of this type these passages should be watched closely if trouble is to be avoided. It is not enough that the passages on the out end of the bearings be free, but the back ones must be kept open also, since all the oil will eventually flow to the end of the bearing that is stopped up and to the outside.

# The Several Efficiencies of the Steam Engine

By F. R. LOW

IMAGINE a cylinder (Fig. 1) one square foot in cross-section, having walls composed of a substance that will not absorb nor give up heat nor let heat pass through it; and fitted with a weightless and frictionless piston; below the piston a pound of water at 212 deg. The atmosphere exerts a pressure of 14.7 lb. per sq.in. on top of the piston. Put on enough weight in addition so that the total pressure is 135 lb. per sq.in. absolute.

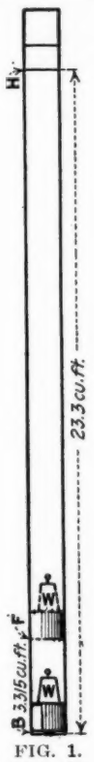


FIG. 1. EXPANSION OF STEAM

Now apply a source of heat to the bottom of the tube, and although I asked you to imagine it to be impermeable to heat, for the present modify that assumption to the extent of allowing heat to flow into the water.

The temperature of the water will rise until it gets to 350 deg. There the rise of temperature will stop, but if the application of heat be continued the water will boil—always at 350 deg.—and as the water changes into steam, the weighted piston will rise. Some of the heat furnished by the fuel is being converted into work.

When the water is all evaporated, the piston will rest on a cushion of steam. If the last trace of moisture has been evaporated and if the source of heat is removed before the temperature of the steam is increased above the 350 deg. at which it was made, the steam will be "dry-saturated" and the piston and weight will have been lifted to 3.315 ft. (*BF*, Fig. 1) less the small depth, 0.0168 ft., occupied by the water at the beginning.

Imagine the source of heat to be removed at this point and the bottom of the tube restored to its adiabatic condition. In the Greek "a" as a prefix signifies *not*. A theist is one who believes in God, an *a*theist one who does not; "dia" signifies through, *dia*meter the "through measure," and "batos" to pass. So adiabatic means not-pass-throughable, and we have this pound of steam in the dry-saturated condition, containing no moisture, but not superheated and shut in by these adiabatic surfaces (for the piston must be of the same character, too), which will not let any heat get to it nor out of it, and will not absorb any of its heat themselves.

Now lift the weight and the steam under the piston will expand. Expansion under these conditions is called "adiabatic expansion." When the weight is removed altogether and there is no force on the piston (which you will remember was imagined to be weightless in itself) except the atmospheric pressure of 14.7 lb. per sq.in., the steam will have gone back in temperature to 212 deg. If none of it had condensed, its volume would have been 26.79 cu.ft., but although no heat could get out through the piston or the walls of the cylinder, some of the heat that was in it before expansion has been converted into the work of lifting the weight—for the steam helped lift it—and some of the steam has, by reason of the loss of that heat, condensed so that its volume is now but 23.3 cu.ft.

Now again imagine the bottom to become permeable to heat and apply a cold substance, a jet of water or a lump of ice. Heat will flow out of the cylinder and the steam will condense. Continue this until the steam is reconverted to a pound of water at 212 deg., and when the weight is replaced, we shall be back to the original condition. We have been through a cycle. This cycle can be represented by a diagram (Fig. 2) like the steam-engine diagram, is which ordinates, or heights, represent pressure and the abscissas, or lengths, volumes. Starting with a pound of water at 212 deg. under 14.7 lb. per sq.in. pressure (*B* in Figs. 1 and 2), it was heated to 350 deg. and its pressure went up along the line *BE* of Fig. 2 to 135 lb. Then it was evaporated and its volume increased from *E* to *F*. Then it was expanded and its volume increased from *F* to *H* in both figures. The curve in Fig 2 shows how its pressure fell at the same time. Then it was condensed and the volum. shrank—always at the same pressure, 14.7 lb., and the same temperature, 212 deg.—along the line *HB*. The area of this diagram is, as those accustomed to work with the steam-engine indicator well know, proportional to the amount of work done; in this case to the heat converted into mechanical energy by a pound of steam worked by adiabatic expansion between the limits of dry saturation at 135 lb. and 350 deg. to 212 deg. and 14.7 lb.

The amount of this energy could be determined by finding the m.e.p. of this diagram and multiplying it by the increase in volume, but there is an easier way.

In Fig. 5 is another kind of a diagram the area of which represents energy, as does that of Fig. 2, but in heat units instead of foot-pounds. Its ordinates or heights are temperatures instead of pressures.

Start at *A* with a pound of water at 32 deg. F., or 492 deg. absolute, for absolute temperatures are used here just as absolute pressures are used in laying out the ideal pressure-volume diagram. At *B* the pound of water has been heated up to 212 deg. F. and *B* is so placed and the curve *AB* so drawn that the area *ABCDA* is proportional to the amount of heat that is required to raise it from 32 to 212 deg., or to the "heat of the liquid" *h* of the steam tables at 212 deg.

The temperature continues to rise along the line *BE* until at 350 deg. F. the water under 135 lb. pressure begins to boil. The area *AEKDA* under the curve *ABE* is proportional to the amount of heat required to heat the pound of water from 32 deg. to 350 deg.

The temperature will go no higher as long as the pressure stays at 135 lb., and heat continues to pour in at the level *EF* until all the water is boiled away. The line *EF* is made of such length that the area *EFGKE* below it is proportional to the amount of heat that it takes to evaporate a pound of water at 135 lb. pressure; the *L* of the steam tables.

The line *EF* is a line of equal temperature and is called an "isothermal" line.

We are now on this diagram in the position when the water had been all evaporated, and the piston, weighted to 135 lb. per sq.in., was at the position *F* in Figs. 1 and 2.

The source of heat was removed at that point, and by diminishing the load the steam (which was so guarded

that no heat could get to or get away from it) was allowed to expand by its own elasticity, by reason of the energy that was in it—until the weight was all removed and there was nothing on the piston but the atmosphere pressure of 14.7 lb.

This process with its increasing volume and diminishing pressure is shown on the pressure-volume diagram, Fig. 2, by the expansion curve *FH*. On the diagram, Fig. 5, it is shown by the vertical line *FH* dropping from the temperature level 350 deg. F—the temperature of of the steam when it began to expand to the level 212 deg. F., the temperature of the steam at the end of expansion. In making this diagram, addition of heat was indicated by movement to the right as by the growth of the line *EF*. Abstraction of heat would be indicated by movement to the left. But during the expansion it was stipulated that no heat should be

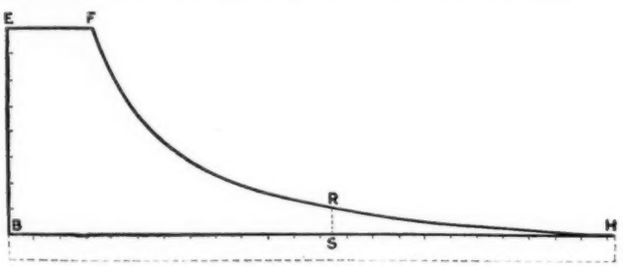



FIG. 2. PRESSURE-VOLUME DIAGRAM OF RANKINE CYCLE

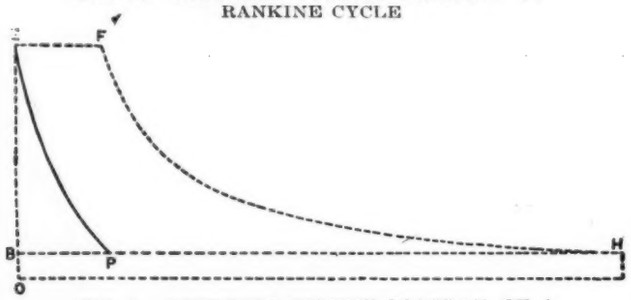



FIG. 3. PRESSURE-VOLUME DIAGRAM OF A CARNOT CYCLE

added to or taken from the steam, so that the change of state is correctly represented by a line that goes from the higher to the lower temperature level without moving to right or left; that is, a vertical. This adiabatic *FH* of Fig. 5 corresponds with the adiabatic *FH* of Fig. 2.

We then imagined heat abstracted until all the steam was condensed, the temperature remaining at 212 deg. This process is represented in both diagrams by the line *HB* showing in Fig. 2 constant pressure, and in Fig. 5 constant temperature (another isotherm). The steam is now all condensed to water and in the condition that we assumed originally in Fig. 1. The cycle has been completed.

The area inclosed by the lines *ABEFHGDA*, Fig. 5, is proportional to the total amount of heat in the pound of steam above 32 deg.; that is, to the total heat *H* of one pound of dry-saturated steam of 135 lb. absolute.

The area inclosed by the lines *BEFHB* is proportional to the heat *U* which has been changed into work. This area is the total area less the area *ABCDA* and the rectangle *BHGCB*. The area *ABCDA* is proportional to the heat of the liquid at 212 deg., which we will call *h*. The height *HG* of the rectangle is proportional to the absolute temperature at the lower level, which we will call $T_2$. The line *MH* is proportional to the total entropy $N_1$ of a pound of dry-saturated steam at 135 lb. and the line *MB* to the entropy $n_2$ of the pound of water at 212 deg. The line *BH*, then, is proportional to $N_1 - n_2$ and the area of the rectangle to $(N_1 - n_2)\ T_2$.

Subtracting both of these from *H* we have

$$U = H_1 - h_2 - (N_1 - n_2)\ T_2$$

Applying this to the case in hand, we find from the steam tables for 135 lb. dry saturated and for water at 212 deg. F.

$H_1$ = 1,191.6 B.t.u. (total heat at 135 lb.).
$h_2$ = 180 (heat of liquid at 212 deg.).
$N_1$ = 1.5777 (total entropy at 135 lb.).
$n_2$ = 0.3118 (entropy of liquid at 212 deg.).
$T_2$ = 460 + 212 = 672 deg.

$$\begin{array}{rrrr} & & 1196.1 = H_1 \\ N_1 = 1.5777 & 212 & 180.0 = h_2 \\ n_2 = 0.3118 & 460 & \overline{1016.1} \quad H_1 - h_2 \\ N_1 - n_2 \text{ or } 1.2659 \times & \overline{672} = & 850.7 \quad (N_1 - n_2)\ T_2 \\ & & \overline{U = 165.4} = H_1 - h_2 - (N_1 - n_2)T_2 \end{array}$$

We got the pound of water at 212 deg., so that we had to furnish 1,196.1 — 180 = 1,016.1 B.t.u. For any

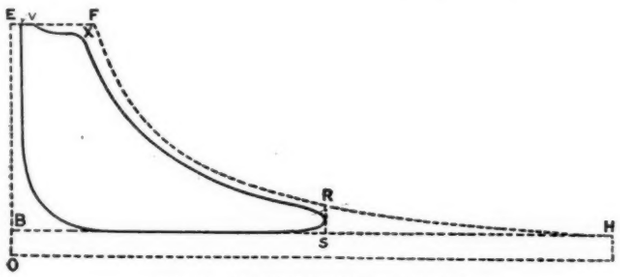



FIG. 4. INDICATOR DIAGRAM

case we would have to furnish $H - h$ heat units, so that the efficiency of the cycle—that is, the number of heat units convertible per heat unit furnished, the ratio of the output in work to the input in heat—is

$$\frac{H_1 - h_2 - (N_1 - n_2)\ T_2}{H_1 - h_2} = 1 - \frac{N_1 - n_2}{H_1 - h_2}\ T_2$$

which equals for our case

$$1 - \frac{1.5777 - 0.3118}{1196.1 - 180} \times 672 = 16.28 \text{ per cent}$$

the same as

$$\frac{U}{H - h} = \frac{165.4}{1016.1} = 16.28 \text{ per cent}$$

The cycle that we have followed is called the Rankine, and the efficiency just computed is the efficiency of the Rankine cycle or the greatest proportion of output to input that could be got with an ideal engine worked between the given limits of quality and temperature on that cycle.

Now suppose that instead of condensing all the steam, we had removed the cooling medium, restored the bottom of the cylinder to its impermeable condition and replaced the weight on the piston while there was still some steam at 14.7 lb. and 212 deg. in the cylinder. We should put some compression into the pressure-volume diagram, and if the point *P* were correctly chosen we

should compress to the initial pressure and make a pressure-volume diagram like Fig. 3.

What would happen in the cylinder Fig. 1 is that the contents would be squeezed back to a pound of water and heated by compression to 350 degrees.

On the temperature-entropy diagram, Fig. 5, this process would be represented by stopping the abstraction of heat along the line *HB* at *P* and compressing along the adiabatic *PE*.

Now in this case we have a pound of water at 350 deg. to start with and all that has to be put in is the latent heat of evaporation. The input will be represented in Fig. 5 by the area *EFGKE* and the heat converted into mechanical energy by the area *EFHPE*. These areas being rectangles of equal width are directly proportional to their heights. The height *FG* is proportional to the absolute initial temperature 350 + 460 = 810 = *T*. The height *HG* is proportional to the absolute final temperature 212 + 460 = 672 = $T_2$. Then the ratio of the area *EFHPE* to the area *EFGKE*—that is, of the heat converted to the heat furnished—is

$$\frac{T_1 - T_2}{T_1} = \text{for our case } \frac{810 - 672}{610} = 20 \textit{ per cent}$$

This cycle, consisting of two isothermals or lines of equal temperature *EF* and *HP* crossed by two adiabatics *FH* and *EP*, is that of Carnot and is the most efficient cycle upon which a heat engine could be operated. The efficiency that we have just computed is the efficiency of the Carnot cycle for the given conditions; that is, the ratio of the output in work to the input in heat of an ideal engine worked upon that cycle between the given limits.

Again, suppose that instead of continuing the expansion away down to the lower temperature level, as at *H* in Fig. 2, we stopped it at *R* or 30 lb. reducing the area of the diagram to *EFRSBE*. The temperature would then be 250 deg. and the first effect of the cooling agent when applied would be to reduce the pressure at constant volume (along the line *RS* of Fig. 2) to 14.7 lb. and 212 deg. When it got to 25 lb., its temperature would be 240, and the point on Fig. 6 would be somewhere on the line *ab*.

By a simple calculation the entropy for this condition can be determined and the point located at *c*. Locating in the same way the points at 230, 220 and 212, we can draw the line *RS* on temperature-entropy diagram, Fig. 6, corresponding to *RS* on the pressure-volume diagram, Fig. 2. The triangle *RSH* in Fig. 6 will represent the energy sacrificed by the incomplete expansion in heat units, just as the area *RSH* in Fig. 2 represents the same quantity in foot-pounds. The area *SRGTS* in Fig. 6 is proportional to the heat withdrawn from the cylinder to reduce the pressure to 14.7 lb. and the temperature to 212 deg., the piston being held meantime at the height to which it had gone when the steam had expanded to 30 lb. The heat convertible by this cycle is proportional to the area *BEFRSB* and less by the area *RHS* than that of the Rankine cycle for the same input.

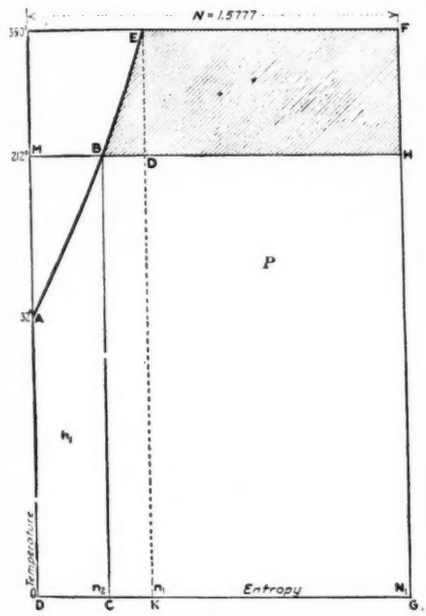



Fig. 5

DIAGRAM OF A RANKINE CYCLE

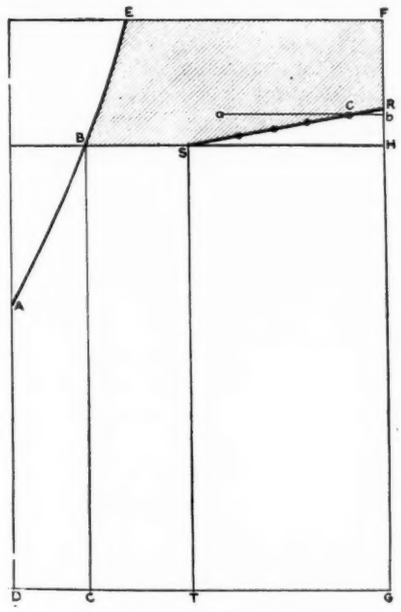



Fig. 6

DIAGRAM OF A CLAUSIUS CYCLE

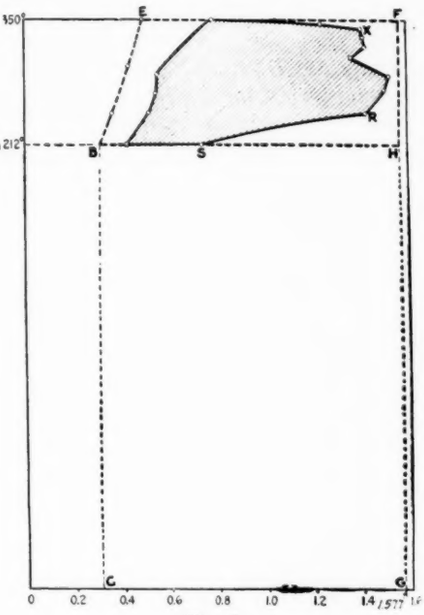



Fig. 7

DIAGRAM OF ACTUAL ENGINE

We have considered three kinds of cycles—the Carnot, the Rankine and the Rankine with incomplete expansion, which, to avoid repeating the description every time it is spoken of, we may call the Clausius. Rankine and Clausius both discussed the cycle which I have called the Rankine, and there is some discussion at to whether it is just to Clausius to adopt Rankine's name for the cycle. It is commonly known by that name, however, among English-speaking engineers, and we may, at least for the present purpose, use Clausius for the Rankine with incomplete expansion.

So much for the ideal engine. When we get to the real machine, we cannot get metal that will not absorb heat from the steam and give it back when the steam becomes the cooler. And then we have clearance and radiation and other complication.

Suppose an engine makes the diagram shown in Fig. 4. Instead of coming back to the line *OE* of zero volume, as it did in the ideal cylinder—except for the volume of the water, so small that it would not show upon the diagram—it comes back only to *V* and the

space *EV* must be filled with steam which, while it takes part in the expansion, does no work upon the piston in entering. Instead of filling the cylinder up to *F*, as it would if it all remained as steam, some of it condenses and at cutoff the cylinder is full only to *X* and at a lower pressure due to wiredrawing. The expansion line, instead of being adiabatic, is thrown upward by the re-evaporation during expansion of some of the steam condensed during admission. There is a loss at the toe of the diagram owing to the necessity of an early release and the sluggishness of the outgoing steam in allowing the back pressure to get down to the lower level. And then, for mechanical reasons and to help fill the clearance, we put in some compression with the result that the work done by the actual engine is only that proportion of the work that would be done by the ideal engine working on the Clausius cycle which the area of its diagram bears to that of the ideal diagram *BEFRSB*. As compared with what would be done by an ideal engine working on the Rankine cycle, its work is in the proportion of the area of its diagram

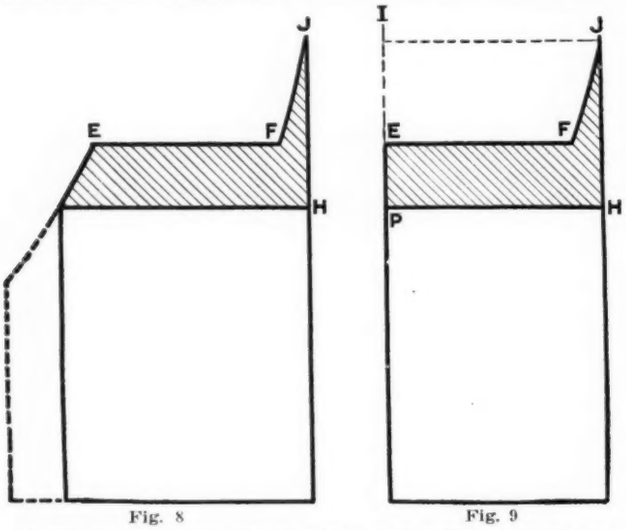



Fig. 8 Fig. 9

TEMPERATURE ENTROPY DIAGRAMS WITH SUPERHEAT
Fig. 8—Rankine Cycle; Fig. 9—Modified Carnot Cycle.

to that of the ideal diagram continued until the curve *FR* met the line *BH*. Fig. 7 shows the diagram Fig. 4 traced upon the temperature-entropy plane.

Then there is the cycle with superheated steam. Assume that instead of taking away the source of heat in the supposed experiment of Fig. 1, it had been left after the water had all evaporated. The steam would rise in temperature and would become superheated. This process is represented by the lines *FJ* of Figs. 8 and 9, and the amount of heat necessary to effect it is proportional to the area under these curves away down to the base line. In these two figures the shaded area is proportional to the convertible heat, the whole area to the heat furnished and the ratio of the two is the efficiency of the cycle.

Notice that although Fig. 9 represents a cycle that would appear on the pressure-volume plane the same as Fig. 4, its efficiency is no longer represented by the $\frac{T_1 - T_2}{T_2}$ formula. For this to be true the whole area *PIJHP* would have to be convertible; that is, all the heat would have to be put in on the high level *IJ* instead of part of it on the level *EF* and part on the different levels between *F* and *J*. This is not then a Carnot cycle, but the cycle with superheat shown in Fig. 8 is a Rankine cycle.

Now what is the significance of all this?

Suppose someone tells you that his turbine or engine is running on 12 lb. of steam per horsepower-hour. That does not allow you to form a very clear estimate of how good its performance really is, or to compare it with the performance of other engines or turbines. What kind of steam was it, wet or superheated? At what pressure was it furnished? How much back pressure or vacuum did it have to work against?

Well, suppose he said that he had 200 lb. pressure, 200 deg. of superheat and a back pressure of 1 lb. absolute. You could compare it with other similar cases with which you were familiar. There is so-and-so with 180 lb. 250 deg. and about the same back pressure, who does a horsepower on 12.5 lb. But suppose you really wanted to know which, under the respective conditions, was the better of these performances.

You could compare them on the heat-unit basis. You could look at your steam table and see that a pound of steam of 215 lb. absolute and 200 deg. superheat has a total heat of 1,309.7 B.t.u. above 32 deg. A pound of water at the temperature corresponding to 1 lb. absolute has 69.8 B.t.u. We must credit such engine with the heat that it furnishes, or could furnish to the feed water, so that the net heat taken by A's engine per pound of steam is 1,309.7 — 69.8 = 1,239.9 B.t.u. and as he uses 12 lb. per hp.-hr. he is getting a horsepower-hour for 1,239.9 × 12 = 14.879 B.t.u.

A pound of steam of 195 lb. absolute and 250 deg. superheat has a total heat of 1,331.6. The lower heat level of B's turbine was the same, so that the net heat per pound of steam in his case is 1,331.6 — 69.8 = 1,261.8, and as he uses 12.5 lb., it costs him 12 × 1,261.8 = 15,142 B.t.u. per hp.-hr. against 14,879 for A.

But this is not a true basis of comparison. The ocean is full of water, but it will not run a turbine because it has no lower level to fall to. The ocean is also full of heat units, but they are of no use to run a heat engine, because they must work between different levels of temperature, and as we have seen, the possible efficiency of the process is, in the case of the Carnot cycle, directly proportional to that difference in temperature levels, and in the other cycles approximately so. A pound of dry saturated steam at atmosphere pressure has 1,150.4 B.t.u. and a pound of steam, also dry saturated, at 200 lb. has only 1,198.1, or 4 per cent more. One would not expect an engine to do as well with the same number of heat units with only a small temperature level to work them through as with a large difference of level.

What can be done is to compare the performance of each with the performance of an ideal engine working on an ideal cycle between the given limits of temperature and condition.

Try it with the Rankine cycle.

In the case of A:

215 lb. 200 deg. 1 lb. back pressure.

$$N = 1.6576 \quad 102 \quad \frac{1{,}309.7\ H_1}{69.8\ h_2}$$

$$n = 0.1327 \quad 460 \quad \overline{1{,}239.9\ H_1 - h_2}$$

$$1.5249 \times 562 = 857.0\ (N_1 - n_2)\ T$$

$$382.9 \mid 2{,}546 \text{ B.t.u.} = 1 \text{ hp.-hr.}$$

$$12 \mid 6.65 \text{ lb. per hp.-hr.}$$

$$55.4 \text{ per cent}$$

The ideal engine would convert 382.9 B.t.u. out of

each pound of steam. A horsepower-hour is equivalent to 2,546 B.t.u. Then the ideal engine would run on 6.65 lb. of steam per hour under these conditions and the engine which takes 12 lb. is running with 55.4 per cent of the efficiency of the ideal engine.

A similar calculation for the other case would show that each pound of the lower pressure steam with the higher superheat would convert 387.6 B.t.u. as against 382.9 for the first case, and as the second turbine took 1.25 lb. it has a "Rankine efficiency," as it is commonly called, of 52.6 per cent as against 55.4 for the first case.

We are told that we must not call this the Rankine efficiency because this will be confused with the ratio of the area *BEFHB* to the area *BEFGCB* in Fig. 5. This is called the Rankine cycle efficiency. It is the heat, $U$, converted in that cycle per net heat unit furnished or $\frac{U}{H-h}$.

The so-called thermal efficiency of the actual engine is the heat converted by it into work divided by the net amount of heat supplied to it—the ratio of the cross-hatched area of the indicator diagram transferred to the temperature-entropy-plane in Fig. 7 to the total area *BEFGCB* of that diagram. Letting $W$ represent the heat equivalent of the work done, this becomes $\frac{W}{H-h}$.

The thing that we figured out to compare the two engines by is the ratio of these two efficiencies: the ratio of the shaded area of Fig. 7 to the area *BEFHB*.

$$\frac{W}{H-h} \div \frac{U}{H-h} = \frac{W}{U}$$ which

for the first case where 215 lb. pressure and 200 deg. superheat were the initial and 212 deg. was the final condition $\frac{212.2}{382.9}$ or 55.4 per cent as above.

The 212.2 is the number $W$ of heat units converted into work per lb. of steam.

$$\frac{2546.5 \text{ B.t.u.} = 1 \text{ hp.-hr.}}{12 \text{ lb. steam per hp.-hr.}} = 212.2 \text{ B.t.u.}$$

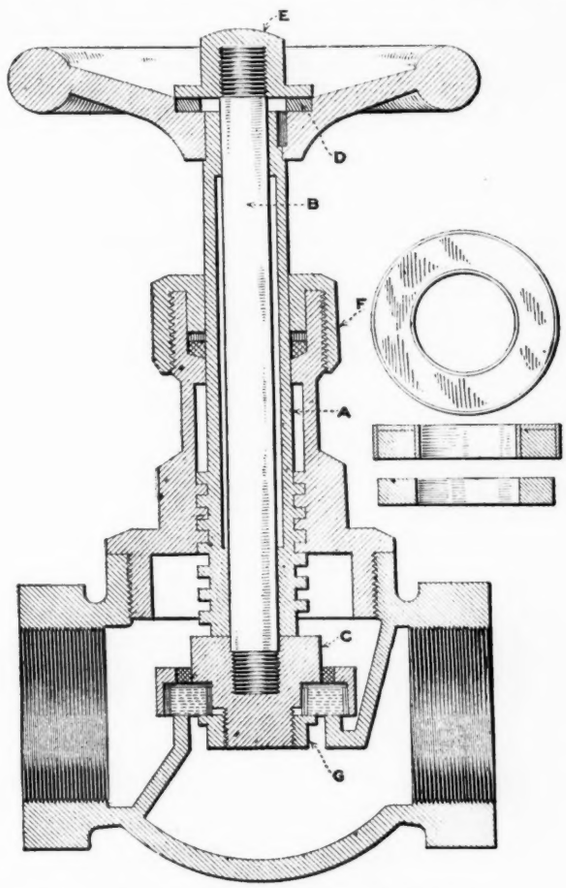
Being a ratio of two efficiencies, it is referred to by the knowing ones as the Rankine efficiency ratio but, as will be seen, the denominators of the two efficiencies are the same $(H_1 - h_2)$ and they cancel out, leaving not a ratio of two efficiencies, but a simple ratio or efficiency, the ratio of the heat converted by the engine to the heat convertible by a perfect engine working under some given condition as of the Carnot, Rankine, Clausius or some mixed cycle. On account of the conflicting claims of the partisans of Rankine and Clausius it is suggested that it be called simply "the efficiency ratio," but this appears to be too inclusive. There are other efficiency ratios. It is also proposed to call it the "engine efficiency" or the "machine efficiency," but the engine or machine has other efficiencies and this would be liable to be confused with the ratio of the brake horsepower to the indicated horsepower, usually called the "mechanical efficiency.

It may be well to indicate this ratio by "engine efficiency" or "cylinder efficiency," but it would seem to be necessary to designate what cycle it is being measured by and the term in common use, the "Rankine efficiency" of the engine, does not seem likely to be confused with the thermal efficiency of the cycle; especially when their numerical values differ so widely.

## McCracken Improved Valve

In the McCracken valve the disc holder is carried by a tube *A* to and from the seat to open and close the valve. A spindle *B* is screwed into the disc holder *C* and is held against the end of the tube *A* by a lock spring *D* and nut *E*.

The stuffing nut and gland *F* are one piece, and the threads of the gland slide over the packing when the valve is being tightened up. Ratchet teeth on the bottom end of the gland slide over the packing when the valve is being tightened, but loosen it at the same time, so that the nut does not have to be as tight as it otherwise would to make a tight joint. As the teeth of the gland become embedded in the packing, upon reversing the nut for renewing packing, the old material is loosened and made easily removable for renewing the packing.



SECTION THROUGH THE VALVE

The disc holder is constructed to hold any form of disc, fiber or solid.

The spindle also can serve the purpose of refacing the seat, as by its use in connection with a cutter it takes the place of the disc. Turning the handwheel gives the desired feed; turning the spindle *B*, using a suitable wrench, performs the operation of refacing and requires no special skill. If a solid disc is used, it may be reground by the same method.

This valve is the invention of George B. McCracken, 55 Mountain St., Willimantic, Conn.

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The better control of economic forces is in fact simply the better comfort of the country.—*Herbert Hoover.*

# Mechanical Storage of Power in Italy*

A PARTICULAR phase of water power that has aroused considerable interest and study in Europe is the storage of hydraulic energy by using surplus power during periods of high water or low demand, to pump water from the tailrace back to a higher level for use during the peaks or periods of drought. This is sometimes known as mechanical storage.

The importance of adequate storage to compensate for daily variations of load and, if possible, for seasonal variations of flow, has long been recognized. But, particularly in the case of low-head development, it is often uneconomical and sometimes impossible to provide sufficient storage on account of the large volume of water involved. In these cases a portion of the surplus low-head power—approximately 40 to 50 per cent—may be recovered by using it to pump smaller quantities of water to a high head, where it may be stored at reasonable expense. This is particularly easy in mountainous countries, where it is usually possible to find small reservoir sites at high altitudes. This water may then be used in a high-head turbine, to carry loads that would otherwise have to be supplied from steam plants.

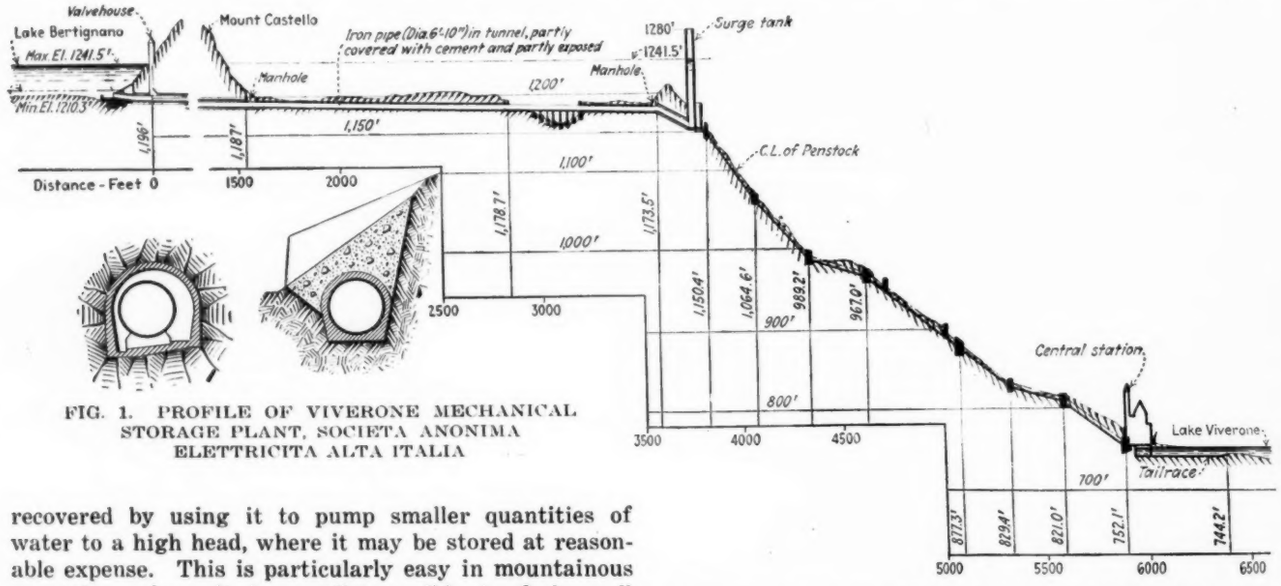


FIG. 1. PROFILE OF VIVERONE MECHANICAL STORAGE PLANT, SOCIETA ANONIMA ELETTRICITA ALTA ITALIA

Low over-all efficiency is the great disadvantage of this system. In the pumping process power is lost in the pump motor, in the pump and in the pressure pipe line. In the utilization of the water more power is lost in the turbine penstock, the turbine and the generator. Assuming the following maximum efficiencies: Motor, 93 per cent; pump, 78; pressure line, 97; turbine penstock, 94; turbine, 97; generator, 94—the over-all efficiency will be 53.5 per cent. This is probably a maximum that could never be reached in practice. But the surplus power costs nothing, so the only items to be balanced are the interest, depreciation, etc., on the capital investment required for the mechanical storage plant, and the cost of steam-generated power. The economy of the system will depend to a great extent on the availability of natural storage reservoirs, owing to the great cost of artificial reservoirs.

Mechanical storage plants must be designed as high-head plants. The higher the head the smaller the quantity of water that has to be lifted, therefore the reservoirs become smaller and less costly, and the pipe lines, though they may be longer, become smaller in diameter. The maximum allowable head is limited mainly by the characteristics of the centrifugal pump.

## The Viverone Plant

The largest hydraulic storage plant in the world is the Viverone Plant of the Societa Anonima Elettricita Alta Italia, Turin. It serves as a regulating and equalizing plant for that company's numerous hydro-electric stations in Piedmont. The suction reservoir is the lake of Viverone, the upper reservoir being the lake of Bertignano, both natural basins. The lake of Bertignano has a storage capacity of 80,000,000 gal., providing sufficient storage for 6,000 kw., the present capacity of the plant. The storage capacity will be increased in successive steps to 127,000,000 and 254,000,000 gal. by raising the dam, in order to keep pace with projected extensions of the plant to 12,000 and 24,000-kw. capacity. The static head on the pump and turbine varies from 458 to 492 ft., depending on the amount of water in the upper reservoir.

The profile of the system is given in Fig. 1. The pipe line from the station to the surge tank is 4 ft. 9 in. in diameter and 2,300 ft. long. That from the surge tank to the lake is 3,400 ft. long and 6 ft. 10 in. in diameter.

The installation consists of four high-pressure combined pumping and generating units, each consisting of a three-phase generator direct-connected through clutches on one end to a horizontal turbine and on the other to a two-stage centrifugal pump. When pumping, the generator operates as a synchronous motor, the set being brought up to speed by the turbine, synchronized and then disconnected from the turbine by means of the clutch. One set has a capacity of 4,500 hp. at 735 r.p.m., two of 2,000 hp. and one of 1,250 hp. at 960 r.p.m.

The upper reservoir can be filled in 38 hours, using the full pumping capacity, which demands 9,400 kw. at the transformer primary. Therefore the total energy consumption to fill the reservoir is 360,000 kw.-hr., of which 176,000 kw.-hr. can be recovered by the turbine at full-load, 165,000 kw.-hr. at three-quarter load, and

*Abstract by Marbot, from a paper by G. Müller, in the *Schweizer Bauzeitung.*

155,000 kw.-hr. at one-half load. The respective overall efficiencies of the system are therefore 49 per cent at full load, 46 per cent at three-quarter load and 43 per cent at half load.

### Funghera Mechanical Storage Plant

Besides the Viverone Station, the same company has owned since 1910 a storage station at Funghera, Italy (Fig. 2). This station is combined with the low-head

FIG. 2. GENERAL VIEW OF THE FUNGHERA STORAGE PLANT, SOCIETA ANONIMA ELETTRICITA ALTA ITALIA

generating station. It consists of one group pump-generator-turbine of 4,000 hp. Unlike Viverone, artificial reservoirs had to be built at a great expense at Funghera. Each of the two reservoirs has a capacity of 13,000,000 gal. When filling the upper reservoir, the lower reservoir is emptied, the lift varying from 440 ft. to 500 ft. The filling time is 8 hours, this being done during the night with the power supplied by the low-head power station. The energy required is 29,000 kw.-hr. for each 1,000 gal. of water lifted.

These two storage plants are entirely satisfactory and come fully up to expectations, so that the company was enabled to entirely shut down its steam stations at Turin.

### A Large Mechanical-Storage Plant Under Construction

Another station of especially large output is the hydraulic-storage plant of the Compagnie des Forges et Acieries Electriques Paul Girod, at Ugine, Savoy, which is at present under construction. There will be four units of a total capacity of 20,000 hp. The lift is about 1,700 ft. The upper reservoir, Lake Girotte, is 5,700 ft. above sea level and has a capacity of 8,000,000,000 gal. As the natural inflow of water to the lake is very small, about half of its capacity has to be pumped into it. The pumping is done during the months of May, June, July; that is, when the large masses of snow melt in the Mont Blanc mountain group. In conesquence of the enormous amount of water at that time, a considerable amount of surplus power is available for storage purposes.

The water stored this way gives up its energy from a head of 4,400 ft. in various pressure stages to turbines, and it is estimated that in this way 9.5 kw.-hr. will be obtained per 1,000 gal. of water.

When this storage plant is finished, it will be able to produce 75,000,000 kw.-hr., which will be a valuable help during the water-poor winter months.

## Welding Broken Armature Shafts Without Removing or Injuring Coils

Large armature shafts occasionally break at the junction of the journal and the pulley end. Although recognizing the adaptability of the Thermit-welding process to the welding of all kinds of large steel shafts, operators sometimes in this case decide to scrap the old shaft, fearing that the heat of the steel produced by the Thermit reaction might injure the armature coils and produce short-circuits.

Where the armature coils, however, can be separated from the fracture by a few inches of molding sand (at least about 4 in. in the case of a 3-in. diameter shaft), a repair by this method is feasible without injuring them (according to a statement by the Metal & Thermit Corporation of New York) if the following simple precautions are observed: There is no danger of damaging the armature windings through the effect of direct heat, as the fracture is surrounded by molding sand and all preheating subsequent to heat from the Thermit steel is confined within this sand. The heat that is conducted along the shaft is readily taken care of either by directing an air blast on the shaft or, where necessary, by means of a specially constructed water-cooling box with packing box on the shaft to prevent the possibility of water coming in contact with the windings. The windings are further protected by being incased in an oilcloth and burlap bag.

In case the keyway of the pulley end of an armature shaft becomes badly worn, this worn end can be removed and a new oversize extension welded on and machined down. Many such extensions have been Thermit-welded in the past.

As an example of costs, in the case of an oversize extension to a 3½-in. diameter shaft, the Thermit welding can be executed for approximately $35, not including machining, with a guarantee by the welders against breakage in service. Smaller shafts can, of course, be welded for correspondingly lower costs.

The building up of worn keyways on the pulley ends of armature shafts is not ordinarily recommended, as experience has shown that, where such keyways have been badly worn, the pulley has been a trifle loose and the consequent chafing has worn the shaft end out of round. Therefore it is usually recommended that the old pulley extension be cut off and a new oversize extension be Thermit-welded to replace it, thereby resulting in a satisfactory job.

# Power-Plant Accounts—XI. The "Surplus" Account

BY WILFRED A. MILLER

THE power plant in a factory may be looked upon as being one of the manufacturing departments. Viewed from this angle, it is entitled to show a profit on its output if it earns a profit. It has been pointed out in preceding articles that the profit that is charged to the departments that use it, cannot be considered in the light of a profit actually realized until the goods that used up the power have been sold to customers of the factory.

To illustrate some of the points that come into play, let us assume that we are keeping our accounts on the principle of charging profit on our output, and as a concrete example let us suppose that at the end of February, 1920, the Profit and Loss account in our ledger had the aspect of the page shown in Fig. 1. From it we see that there was a profit of $200 in January, but a loss of $50 in February, making a net profit of $150 for the two months. Unless we had made the reservation already dwelt upon regarding the availability of the profit, there would seem to be no reason why we should not use this profit for any purpose we saw fit, as, for example, for the purchase of some instruments, or we might turn it back into the treasury of the concern as our contribution to the general profits. If it were a real profit, some such use of it should be made, as it would be rather ridiculous to accumulate a profit merely for the pride of having it appear on the books. Generally speaking, the only object of conducting an enterprise is to create a profit, and the only object of creating a profit is to distribute it among the owners of the enterprise.

> This is the eleventh of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment shows when and how profits may be transferred from the "Profit and Loss" account to "Surplus" account.

Since we are not the owners of the factory, we cannot appropriate the profits for our own personal use. Neither can we expect to use all the profits we make in buying new equipment. If we did that, it would be the same as if the factory itself were to spend all the money it made in paying for new apparatus. The owners might be willing to spend part of the profits in that manner, but first of all they would expect to get part of it themselves for their personal use. Since the power plant is one unit in the factory, it must be content to turn over part, or perhaps all of its profit for the personal use of the owners. That, after all, is its ultimate use. If new equipment has to be bought for the power house, the owners are the ones who must furnish the funds for the purpose. Whether they derive them from some part of the profits of their business or in some other way makes no difference to the power plant. So long as the equipment is forthcoming, we are satisfied. However, from a practical standpoint it is the part of conservative management to set aside a part of earnings as a fund to meet contingencies before making a distribution of the profits among the owners. We will therefore assume that such a policy is in force in our plant. Furthermore, we will make the assumption that the rate of profit allowed to the power plant is so small that its total earnings may be set aside as a reserve fund instead of appropriating part of them to be applied to the profit of the factory in general.

To come back to our Profit and Loss account as illustrated in Fig. 1, we would, as before stated, be entitled to use the balance of the profit if we had made no reservations regarding its use. As a matter of fact we know that we are not permitted to dispose of it until the firm has actually collected for it from its customers. The question then arises, How do we know when any part of it has been paid, and how much that part amounts to? To answer this question fully and accurately would carry us into the field of cost accounting for the entire factory, a thing that we are not prepared to consider. Two plans, however, present themselves. If our concern keeps costs of its manufacturing activities, we may be able to get a figure from the accountant in charge of the books, at the end of each month, telling us how much of our profit has been cashed in on. Even if these figures are not available, he will be able to aid us in arriving at a figure that will be a good deal more reliable than any we are likely to concoct ourselves. Lacking such a source of information, we are thrown on our own resources. The best thing for us to do in that case is to try to form some estimate as to the average length of time that elapses between the time at which power is used in the manufacture of an article and the time when it is sold. It goes without saying that our results are going to be nothing but rough approximations, because there are so many factors to be considered. However, we will probably be able to form some estimate, such as two weeks, or ten weeks, or six months. It is not of extreme importance to get it closely.

In order to deal with a concrete example, let us assume the following facts. Average time for which power is "tied up" in product: Dept. A, 2 months; Dept. B, 1 month; Dept. C, 3 months. Suppose now that we started our books on Jan. 1, 1920, and that we have established a fixed rate at which to charge our power, say 2c. per kw.-hr., electrical power being the only kind that we are called upon to supply. Under these conditions we find that our charges for January, February, March and April are as follows:

| Month (1920) | Dept. A | Dept. B | Dept. C | Total |
|---|---|---|---|---|
| January | $3,000 | $1,000 | $2,000 | $6,000 |
| February | 2,500 | 800 | 1,800 | 5,100 |
| 2 months' total | $5,500 | $1,800 | $3,800 | $11,100 |
| March | 3,200 | 1,100 | 2,300 | 6,600 |
| 3 months' total | $8,700 | $2,900 | $6,100 | $17,700 |
| April | 2,900 | 900 | 2,100 | 5,900 |
| 4 months' total | $11,600 | $3,800 | $8,200 | $23,600 |

During the same period our costs were as follows: January, $5,800; February, $5,150; March, $6,300:

April, $5,750; total, $23,000. Our profits and losses for the four months would therefore be

| | |
|---|---|
| January, Profit | $200 |
| February, Loss | 50 |
| 2 months' total, Profit | $150 |
| March, Profit | 300 |
| 3 months' total, Profit | $450 |
| April, Profit | 150 |
| 4 months' total, Profit | $600 |

We have estimated that it takes one month for the product manufactured by Dept. B to cash in on the

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PROFIT AND LOSS

| DATE | EXPLANATION | REF | AMOUNT | DATE | EXPLANATION | REF. | AMOUNT |
|---|---|---|---|---|---|---|---|
| 1920 Feb. 29 | Loss | | 50 — | 1920 Jan. 31 | Profit | | 200 00 |
| | | | | | 150 — | | |

FIG. 1. PROFIT AND LOSS ACCOUNT AT END OF FEBRUARY

power profit, therefore it is reasonable to suppose that by the end of February all the power used by Dept. B in January has been disposed of in goods sold to customers during February. Going on this assumption, we are permitted to consider the profit made on the January charge to Dept. B as available for disposal at the end of February. Similarly, at the end of March we may dispose of the January profit charged to Dept. A, since its product is disposed of in two months. And finally, at the end of April we may use the profit charged to Dept. C in January, because the goods produced by it are disposed of in three months. It must be understood that this method of figuring gives us only rough approxima-

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1920 Feb. | 29 | Profit and Loss | Transfer to Surplus | 33 | — | | |
| | | 29 | Surplus | Transfer from P&L | | | 33 | — |
| | Mar. | 31 | Profit and Loss | Transfer to Surplus | 92 | — | | |
| | | 31 | Surplus | Transfer from P&L | | | 92 | — |
| | Apr. | 30 | Profit and Loss | Transfer to Surplus | 92 | — | | |
| | | 30 | Surplus | Transfer from P&L | | | 92 | — |
| | May | 31 | Profit and Loss | Transfer to Surplus | 151 | — | | |
| | | 31 | Surplus | Transfer from P&L | | | 151 | — |

FIG. 2. JOURNAL ENTRIES FOR TRANSFERS BETWEEN PROFIT AND LOSS ACCOUNT AND SURPLUS ACCOUNT

tions and that our judgment of actual conditions often leads us to revise them quite radically.

It now remains to find how much profit was charged to each department in each month. This is a simple matter. We know how much we charged to each department for its power, and we know how much profit we made on the entire quantity of power supplied. Hence all we have to do is to divide the total profit in proportion to the charges to the various departments. Thus, we have:

Profit on power charged to Dept. A *IS TO* Total Profit
*AS*
Power charged to Dept. A *IS TO* Total power charge.

In the month of January this would give us:

Profit on power charged to Dept. A : 200 :: 3,000 : 6,000

from which we find that

$$\text{Profit on power charged to Dept. A} \times 6{,}000 = 200 \times 3{,}000 = 600{,}000$$

and therefore, that

$$\text{Profit on power charged to Dept. A} = \frac{600{,}000}{6{,}000} = \$100$$

For February we would get

$$\text{Loss on power charged to Dept. A} = \frac{125{,}000}{5{,}100} =$$

$25 approximately

Following the same procedure for all the departments for each of the four months will give us in round numbers the results shown in the tabulation herewith.

| Month | Profit or Loss | Dept. A | Dept. B | Dept. C | Total |
|---|---|---|---|---|---|
| January | Profit | $100 | $33 | $67 | $200 |
| February | Loss | 25 | 8 | 17 | 50 |
| March | Profit | 145 | 50 | 105 | 300 |
| April | Profit | 74 | 23 | 53 | 150 |

From this table and a knowledge of the average time for which power is "tied up" in the various departments

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PROFIT AND LOSS

| DATE | EXPLANATION | REF | AMOUNT | DATE | EXPLANATION | REF. | AMOUNT |
|---|---|---|---|---|---|---|---|
| 1920 Feb. 29 | Loss | | 50 — | 1920 Jan. 31 | Profit | | 200 — |
| 29 | Transfer to Surplus | | 33 — | Mar. 31 | Profit | | 300 — |
| Mar. 31 | Transfer to Surplus | | 92 — | Apr. 30 | Profit | | 150 — |
| Apr. 30 | Transfer to Surplus | | 92 — | May 31 | Profit | | 250 — |
| May 31 | Transfer to Surplus | | 151 — | | | | |

FIG. 3. PROFIT AND LOSS ACCOUNT AT END OF MAY

we can deduce the results shown below. The amounts in black-face figures represent losses, and must therefore be subtracted from profits to get the net totals.

| Month | Amount of profit released for use Dept. A | Dept. B | Dept. C | Total |
|---|---|---|---|---|
| January | None | None | None | None |
| February | None | $33 | None | $33 |
| March | $100 | 8 | None | 92 |
| April | 25 | 50 | $67 | 92 |
| May | 145 | 23 | 17 | 151 |

From this tabulation we see that at the end of January we have no profit to use, but that at the end

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SURPLUS

| DATE | EXPLANATION | REF | AMOUNT | DATE | EXPLANATION | REF | AMOUNT |
|---|---|---|---|---|---|---|---|
| | | | | 1920 Feb. 29 | Transfer from P&L | | 33 — |
| | | | | Mar. 31 | Transfer from P&L | | 92 — |
| | | | | Apr. 30 | Transfer from P&L | | 92 — |
| | | | | May 31 | Transfer from P&L | | 151 — |

FIG. 4. SURPLUS ACCOUNT AT END OF MAY

of February we may consider $33 as being available, at the end of March $92, at the end of April $92, and at the end of May $151. If we attempted to carry the tabulation any further, we would find that for June we would

have no information for Dept. B, in July none for Dept. A and B, and in August none for any of the departments. Therefore, before we went any further we would have to know the profits for the months following those introduced in our example; namely, for the months following April. Only one other thing need be called to our attention, and that is that when losses occur they are handled in precisely the same manner as are profits. That is, we are not actually penalized for them until the goods are sold.

We have now arrived at the point where we know how much profit we may make use of each month. It remains

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1920 June | 30 | Profit and Loss | Transfer to Surplus | 172 | – | | |
| | | 30 | Surplus | Transfer from P & L | | | 172 | – |
| | July | 31 | Profit and Loss | Transfer to Surplus | 133 | – | | |
| | | | Surplus | Transfer from P & L | | | 133 | – |
| | Aug. | 31 | Surplus | Transfer to P & L | 35 | – | | |
| | | 31 | Profit and Loss | Transfer from Surplus | | | 35 | – |

FIG. 5. JOURNAL ENTRIES FOR TRANSFERS OF PROFIT DURING JUNE, JULY AND AUGUST

for us to find out how to record the facts in our books. What we must do is to remove from the Profit and Loss account in our ledger the amount that we find each month to be available for use. If we remove it from the Profit and Loss account, we must put it somewhere else. In order to accomplish this we may set up another account in our ledger and transfer to it whatever amounts we remove from the Profit and Loss account. Suppose that we do this. The next question is, What shall we call this new account? We cannot very well call it the Profit account, because we already have a Profit and Loss account. Suppose we name it Surplus account, which makes our list read as follows:

(*a*) Direct Expenses
(*b*) Indirect Expenses } (*A*) Total Cost
(*c*) Investment
(*d*) Income
(*e*) Profit and Loss
(*f*) Surplus

Having decided on a name for the account our next step is, of course, to select a page for it in the ledger

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PROFIT AND LOSS

| DATE | | EXPLANATION | REF | AMOUNT | | DATE | | EXPLANATION | REF | AMOUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1920 Feb | 29 | Loss | | 50 | – | 1920 Jan | 31 | Profit | | 200 | – |
| | 29 | Transfer to Surplus | | 33 | – | Mar | 31 | Profit | | 300 | – |
| Mar | 31 | Transfer to Surplus | | 92 | – | Apr. | 30 | Profit | | 150 | – |
| Apr. | 30 | Transfer to Surplus | | 92 | – | May | 31 | Profit | | 250 | – |
| May | 31 | Transfer to Surplus | | 151 | – | Aug. | 31 | Profit June | | 275 | – |
| June | 30 | Loss | | 200 | – | | 31 | Transfer from Surplus | | 35 | – |
| | 30 | Transfer to Surplus | | 172 | – | | | | | | |
| July | 31 | Loss | | 100 | – | | | | | | |
| | 31 | Transfer to Surplus | | 133 | – | | | | | | |

FIG. 6. PROFIT AND LOSS ACCOUNT AT END OF AUGUST

and to make a memorandum of it and its page number in the index which we have established on the first page of our ledger. We are then ready to make entries to it. These entries must, as usual, come as postings from our journal, and we are therefore next concerned with the journal entries which we must make to record the facts.

What we want to do is to remove a certain sum from the Profit and Loss account and transfer it to the surplus account. What this means is that the Profit and Loss account must pay that much to the Surplus account. That is, the Profit and Loss account pays out something and the Surplus account receives something. Therefore to accomplish the transfer we must make two journal entries, one showing the payment made by the Profit and Loss account and the other indicating that the payment was received by the Surplus account. The former will require an entry of the amount in the left-hand column and the latter its entry in the right-hand column. Taking the figures that we worked out in our example, our journal entries for them would look something like those shown in Fig. 2. Posting these would make the Profit and Loss account in the ledger look like Fig. 3 and the Surplus account like Fig. 4. The Profit and Loss account contains the monthly postings for the profits and losses, as well as those for the transfers. The journal entries from which the former postings were made are not illustrated since it is very easy to see how they got into the ledger without such an illustration. It will also be observed that a posting of $250 profit in May is indicated, although no May profit is discussed in the example. This amount has been chosen arbitrarily

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SURPLUS

| DATE | | EXPLANATION | REF. | AMOUNT | | DATE | | EXPLANATION | REF. | AMOUNT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1920 Aug. | 31 | Transfer to P & L | | 35 | – | 1920 Feb | 29 | Transfer from P & L | | 33 | – |
| | | | | | | Mar | 31 | Transfer from P & L | | 92 | – |
| | | | | | | Apr. | 30 | Transfer from P & L | | 92 | – |
| | | | | | | May | 31 | Transfer from P & L | | 151 | – |
| | | | | | | June | 30 | Transfer from P & L | | 172 | – |
| | | | | | | July | 31 | Transfer from P & L | | 133 | – |
| | | | | | | | | Aug. 635 – | | 635 | – |

FIG. 7. SURPLUS ACCOUNT AT END OF AUGUST

just to have an item for May. If we showed no such posting, we could not present a complete account up to the end of May because the May profit would be missing.

It is of course possible that instead of being able to transfer an earned profit from the Profit and Loss account to the Surplus account, we might sometimes be called upon to stand for a loss. In that event we would have to draw upon our Surplus account to make good the shortage. In other words, the Surplus account would have to pay the amount of the loss to the Profit and Loss account. To illustrate such a case, let us suppose that the months June, July and August reveal the following facts: June, Loss, $200; profit to be transferred, $172. July, Loss, $100; profit to be transferred, $133. August, Profit, $275; loss to be transferred, $35.

Such being the case it is evident that the journal entries for the Profit and Loss and the Surplus transfers would be like those indicated in Fig. 5 and the ledger accounts would have the appearance presented in Figs. 6 and 7 after these and the other necessary journal entries had been posted. From the ledger accounts we gather that at the end of June our potential profits were $110 and those available $540. At the end of July

the Profit and Loss account showed a loss of $123, although our available profits had increased to $673. At the end of August the Profit and Loss account again showed a profit, amounting to $187, whereas the Surplus account had decreased to $638.

The next step to be considered would of course be the disposal of the amount that is gradually building up in the Surplus account. However, we shall not concern ourselves with that for the present, as we can readily allow it to accumulate for the space of a year if no urgent need for it develops. Just how we can handle the matter when we do want to dispose of some or all of the accumulated profit will be taken up when we get further along in our work.

## Why the Engine Would Not Start

By E. E. Long

Some time ago I was sent by a manufacturer to install a large semi-Diesel oil engine that was to drive a flour mill in the South. When the job was about finished, I was requested by the miller to go to a neighboring town, where a 50-hp. semi-Diesel was driving a cotton gin, but for some reason would no longer run.

Dropping into this plant the next day, I was taken out to the engine room. The ginner explained that he had always employed a man to run the engine, but had let him go in order to reduce expenses. The engine required but little attention, and the ginner thought that his helper could attend to the oiling, etc.

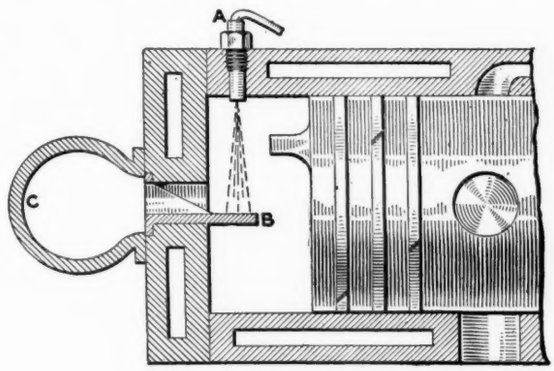
To show me how the engine refused to start, the ginner lighted the kerosene starting torch. This torch was connected to a hand or bicycle pump which provided the air blast. The ginner was middle-aged and by no means thin, and, as a consequence the operation of the hand pump soon had him breathing rather heavily. He pumped and rested alternately for about a half hour. He then decided the bulb was hot enough, so turned on the air starter and kicked the engine over a few times. The engine seemed to ignite, but as soon as the air was cut off the starting valve, it fired but once, kicked backward and then oscillated back and forth. It was quite apparent that the fuel charge had fired too early, causing the engine to turn over in the wrong direction, and then the piston coming up against the compression was forced downward again.

I assumed that the fuel-pump cam had shifted, causing the oil to be injected very early in the compression stroke. Early fuel injection, if the engine compression is high or the bulb very hot, will cause the fuel charge to ignite very early. Upon checking the cam timing, it was found that the injection of oil started at 30 deg. before dead center, this being the proper timing for this type of engine. The fuel-pump was then examined for leaky valves on the assumption that oil had dribbled into the cylinder and preignited. All valves were found in good shape.

We spent considerable time going over the engine, finally knocking off for lunch. Upon going back to the mill after lunch, I found no one there, so to speed things up I started the hand torch. Pumping rather briskly I soon had the combustion chamber hot and then opening the starting air valve, kicked the engine over. To my surprise the engine started firing and, picking up speed, was soon running in a normal way. The ginner arrived while it was running and rather suspected I was hiding something when I declared that I had made no adjustment before starting the engine.

We ran the engine for a couple of hours under load, then shut it down and started it again. Everything was fine and I went back home. The next morning I found the ginner at the mill with the announcement that the engine had refused to run that morning. I got in his automobile and rode over to the gin. Lighting the torch, I heated the head and soon had the engine running nicely. After stopping the engine, the owner started it up again without any trouble. At his suggestion the engine was stopped and the head allowed to get cold. He then started the torch, working laboriously at the hand pump. Upon turning the engine over he found that the oil preignited and the engine kicked back. As he had worked over the hand pump, I had received a glimmer of information. So I told him that if the engine was to run he would find it necessary to either hire an engineer who was not fat or put a pipe line from the air-starting tank to the starting torch. The two seemed so utterly unconnected that he imagined I was kidding.

The why of the premature firing was this: The engine cylinder head and hot bulb were somewhat like



COMBUSTION CHAMBER

the sketch. The oil from the nozzle *A*, when the engine was up to speed was injected into the cylinder immediately over the projection *B*, which, being uncooled, was always red hot. With ordinary fuel oil the oil jet never reached *B*, but was picked up by the air displaced by the piston and forced into the bulb. This, being red hot, ignited the charge. With anything like normal speed a variation of a fraction of a second in the timing of the explosion made little difference. The engine, owing to the momentum of the flywheel, turned over in the proper direction. If the bulb became too hot, a water drip cooled the bulb *C* and spoon *B*, preventing preignition.

When starting the engine, however, a change in the time at which the oil exploded after being injected would seriously affect the operation. If early, the engine would run backward. Now, as usually started, the bulb *C* is heated, but the spoon *B* never gets very hot. Even if the oil strikes the spoon, it is never vaporized and heated sufficiently for ignition until the oil or vapor strikes the bulb. The ginner, being fat, pumped slowly on the torch pump. The blast flame was never intensely hot, so the bulb did not become highly heated until the flame had been applied for a long time. During this extended heating period the spoon *B* absorbed a lot of heat from the bulb and became very hot. As soon as the oil was injected, it struck the spoon and, vaporizing, ignited prematurely. Consequently it was necessary to run the hand pump very fast, obtaining an intensely hot

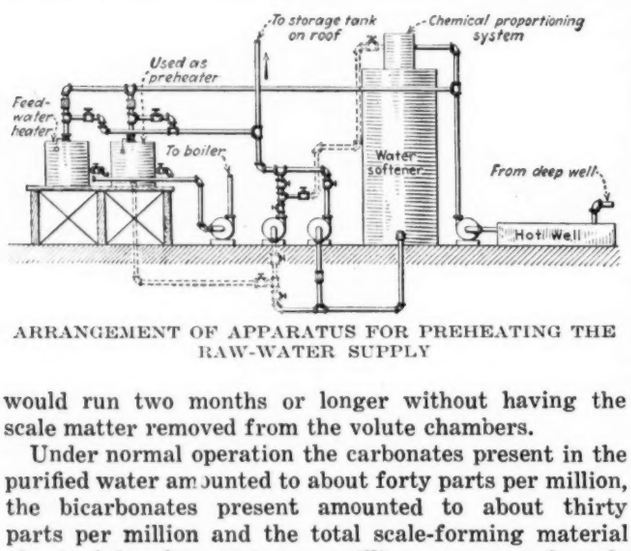
blast flame; the bulb then absorbed heat rapidly and became red hot before the spoon was more than warm. The alternative was to run an air line from the starting air tank to the torch. This was done, and no further starting troubles occurred.

## Efficiency of Water Purification Increased by Emergency Heating Method

BY J. ELMER HOUSLEY

An occasion arose last winter that threatened to close the boiler feed-water lines and pumps of a large industrial plant power house with scale. The trouble was occasioned by using cold raw water going to the lime-soda process water softener.

Previous to the time the trouble developed, the raw water was taken from the discharge of the jet condenser of a low-pressure turbine, which heated the water sufficiently to secure fairly rapid and efficient purification with the standard lime and soda treatment. Owing to changes in the use of exhaust steam for mill purposes during curtailed production, the low-pressure turbine was shut down. Very soon it appeared that the pipe lines between the boiler feed-water heater and boiler-feed pumps, as well as the centrifugal pumps themselves, were scaling up so rapidly that the pumps would become choked in about a three weeks' run, while previously they




ARRANGEMENT OF APPARATUS FOR PREHEATING THE RAW-WATER SUPPLY

would run two months or longer without having the scale matter removed from the volute chambers.

Under normal operation the carbonates present in the purified water amounted to about forty parts per million, the bicarbonates present amounted to about thirty parts per million and the total scale-forming material about eighty-five parts per million, or approximately five grains per U. S. gallon. After the excessively cold water coming directly from deep wells was used for the purifier supply, it was found that the carbonates had increased to about one hundred parts per million, or 250 per cent of normal, the bicarbonates had increased to about sixty parts per million or 200 per cent of normal and the total scale-forming matter to an average figure of one-hundred-eighty parts per million or 210 per cent of the normal quantity.

After a thorough investigation of the purifying process it was evident that we could not obtain water with the apparatus as it stood, which would stand heating to 200 deg. F. and not precipitate in the piping system before reaching the boilers. Should it reach the boilers, the large quantity of scale could hardly be blown off. Solubility tables show that calcium carbonate is more soluble in cold water than in hot. The solubility of calcium carbonate in water (Sparks) at 60 deg. F. is 43 parts per million and at 212 deg. F. is 25.8 parts per million. As the salts in the water are largely composed of carbonate, the trouble was evidently caused by the carbonates being precipitated upon being heated to near the boiling point in the feed-water heater. The bicarbonates would not be precipitated until after 212 deg. F. and consequently would not cause trouble in the pipe lines and pumps. A much slower reaction takes place when using cold supply water, and if the sludge is to be removed by the usual excelsior and burlap filter a much longer time must be allowed for the sludge to settle out before attempting to filter. Also the precipitate is in finer particles using the colder water, while it is heavy and flocculent with warm water of 125 deg. F. and upward.

Investigation was immediately made, looking toward securing a means of preheating the raw-water supply to the purifier during the period of low production, which involved the shut-down of the low-pressure turbine. Two feed-water heaters were in use, and as one of them could be released from service, it was decided to use it as a "preheater" for the raw water to the purifier. There being two pumps, one a spare, used for pumping the purified water to the heaters and storage tank, one of them was connected for pumping the hot water from the preheater to the mixing chamber of the purifier. Valves were arranged so that the "preheater" could be used for heating the boiler-feed water when the regular heater was down for cleaning, which was about once every three weeks. At such time cold water was used for the supply to the purifier for a few hours. In this way both heaters were available for use for feed-water heating. The water going through the preheater was heated to 130 or 140 deg. F., and excellent results were then secured from the chemical treatment of the water. During cold weather we experienced an average drop in temperature of 30 to 40 deg. F. in the water going through the purifier, the purified water entering the boiler feed-water heater at about 100 deg. F. and leaving at about 200 deg. F. No difficulty has since been experienced from the rapid scaling up of the feed lines and pumps with the attendant shutdowns due to clogged lines and burned-out pump thrust bearings, which follows when the equalizing holes of the centrifugal boiler-feed-pump impellers become closed with scale.

Five extra valves and a few sections of pipe were required to make the change on the heater and pump, including a new line run from the preheater pump to the purifier. Sufficient steam was available from the auxiliary drives to make up the heat lost by radiation from the purifier tanks, which was the only additional steam required. Two new recording thermometers were installed, one on the cold-water line to the preheater and one on the line from the preheater to the purifier.

As shown by the sketch of the piping, the feed-water heaters have both a pure-water connection and a mill supply or hotwell connection. When using the preheater, the connection is opened from the hotwell and the preheater is then under float control. The water then goes from a side connection in the heater to its pump and then to the purifier by opening the proper valves. Control of water to the purifier is by hand regulation of the valve in the discharge line of the pump. The capacity of the purifier is large enough to absorb ordinary fluctuations, and the purifier float is observed and regulation made about once every hour or two as found necessary.

# EDITORIALS

## Water Costs and Coal Costs

THERE has developed an idea among those not closely associated with the subject that the one great drawback to development of our water powers has been the lack of favorable Federal and state laws. This undoubtedly has in many cases retarded progress, but the cheapness of fuel has been the controlling feature in many others. It is frequently said that water does not cost anything; in the same sense it can be said that coal has no value. Coal in the ground does not cost anything; neither does water that runs to waste at an undeveloped power source. The cost of either comes only when it is utilized. Before the energy in coal is available for power purposes, it must be mined and transported to a power plant, and the expense of doing this plus a profit represents its cost. With water power the flow of the water must be controlled, which is usually done by the construction of a dam, in many cases an expensive undertaking requiring a large investment; then the water must be transported to the power plant, which requires the construction of tunnels, pipe lines, open ditches, penstocks, etc., depending upon the conditions, and not infrequently these require large investments. The interest on these two investments plus maintenance, operation and depreciation charges represents the cost of water at the power plant and is just as tangible a cost as that of coal. The cost of either is represented in the expense of making them available, and the cost of the water to produce a kilowatt may be equal to or even higher than the cost of the coal.

The analogy may be carried further in that with few exceptions the water available will vary over wide ranges for different seasons of the year and provisions must be made for storing during periods of flood water to be used when the run-off is small. Coal in general is easier to obtain during the summer months than in the winter, so that most large power plants provide storage facilities, not only to help tide over the latter period, but also as an insurance against other contingencies. But all these add to the cost of making the water or coal available at the plant and the cost per kilowatt-hour at the busbars.

In the power plant practically everything is in favor of water power. The investment is generally lower, operating charges are lower an the rate of obsolescence is low and the efficiency is high. Where the over-all efficiency at the hydro-electric station may be as high as ninety per cent, that for the best steam-electric plants is less than twenty per cent. In general it can be said that the cost per kilowatt at the busbars of the hydro-electric plant is lower than for the steam plant, and in some cases much lower.

It is to deliver the power from the busbars to the customer that the hydro-electric plant is frequently at a great disadvantage. While the steam plant can be and generally is built near the load center, the hydro-electric plant may be a great distance away and necessitate the construction of a long and expensive transmission line, and this not infrequently puts the water-power project out of competition with the steam plant. However, as transmission lines spread out over the country, the solution of this problem will tend to be brought about automatically, in that many of the water-power sites that cannot be economically developed at present will be brought within short distances of these transmission systems. Not only will this cut down the cost of transmission from the water-power plant, but it may also make possible a much cheaper development, since the plant will have the advantage of feeding into a large system.

## Cause of Failure of a Large Steam Turbine

WHEN, in September, a thirty-thousand-kilowatt turbine-driven unit at its Schuylkill Station broke down, the Philadelphia Electric Company retained Prof. H. F. Moore, of the University of Illinois, and Dr. G. L. Kelley, a metallurgist of Philadelphia, to determine, if possible, the cause and manner of the failure.

Through the courtesy of the officials of the company we have been afforded access to the reports of the experts, and the article in this issue is based upon and largely quoted from these sources.

The accident, as shown clearly by the nature of the fracture, is in the same class as others that have occurred, the cause being axial vibration of the wheel. This has been made the subject of expert study and extensive experimental research, and is now so thoroughly understood that such vibration can be avoided in proportioning wheels of up-to-date design.

A subsequent examination of the diaphragms brought out a point not mentioned in either of the reports; that is, that the diaphragm next to the wheel that failed had been rubbed by the bucket shroud band, the indentation due to the wear of the band in the diaphragm being as much as one-eighth of an inch around the entire periphery. The turbine engineers of the General Electric Company feel that in all probability this is the exciting cause for the axial vibration referred to by Professor Moore and that it probably occurred from time to time when the machine was being put into service and before the entire structure became uniformly heated.

Few who have not been intimately in touch with it appreciate the stupendous work that has been done in a comparatively few years in developing the turbine to its commanding position as a prime mover of large capacity. The problems connected with rotating huge masses of metal at velocities that would have staggered the engineers of a few decades ago; of stress and distortion involved by a temperature range in a short span of metal from that of the highly superheated steam to that of the condenser, varying in its distribution with each change of load; problems imposed by harmonic vibration, the procuring and treatment and working of new materials under untried conditions—these have involved the exercise of skill and patience and ingenuity

and such expenditure of brains and money that its story, could it be written, would furnish one of the most striking chapters in industrial history. It is fortunate for all who depend upon power produced from fuel—and who does not?—that there have been organizations of talent and capital that have had the means and faith and devotion to see the turbine through its formative stages and to bring it to its present state of reliability and efficiency.

## Business Methods for the Engineering Society

"ARE you doing your duty by the organization, or are you a slacker?" "Are you giving the best effort there is in you to our society?" "Are you unselfishly backing up the officers in their efforts to make our organization a success?" Strong language! Yet it is often heard at meetings of engineering societies, especially the small ones and the small locals of larger bodies. It is the call to arms that is sung out when attendance falls off and interest fails. It deserves to be the swan song.

An engineering society or any similar organization is not a philanthropy; it is a co-operative enterprise. Groups are sometimes formed for altruistic purposes, but the "duty to the association" idea bobs up among men that organize for purely selfish motives, and that attend meetings for what they can learn; such folks stay away when they can see nothing of especial value to them in the program or when they simply feel lazy. Will they put on their hats and come to meeting at the inspiring call "Stand by the organization?" They will not.

Officers that make such appeals have the wrong point of view. They are generally willing to put a lot of effort into work for the organization; then, because their intentions are good, they expect the members to respond instantly. The members have other things to worry about.

The advantages of membership bring obligations. Some members will be called upon to do committee work, others to give papers or to take part in discussions. If no one wants to do this work, there will be no advantages in membership. It is up to the officers to put that fact over to the members. On the other hand, if there are no advantages, obligations will be forgotten. The officers should put that fact over to themselves.

Why not look at it this way? The members joined for a certain reason, presumably to learn something. What is this something? Ask them if necessary. Then give it to them. If the program is carefully arranged, well carried out and fully announced, and yet the members fail to respond, then there is something wrong with them, and the officers are wasting their time. If the officers, however, fall down on their jobs, then there is something wrong with them, and they ought to improve their methods. But how? Let them turn for their answer to the business man, who has similar but far more difficult problems to meet.

Not many years ago goods were bought. That is, a man would set himself to making some product just as well as he possibly could, and then people would come and buy it. Today it is different; it is not enough to make a good product—one must also sell it, and sell it actively, aggressively and constantly. The meteoric development of advertising attests that fact. How, then, can an engineering society official apply to his own problems the successful methods of the business man?

A number of things can be done, but they are all included in the word "sell." He must sell the organization and its work to the members. This little word "sell" sums up a fundamental principle of modern business, which is to go out after your customer and make him want what you have to offer him. Thus, when there is excited the kind of interest in a proposition that leads to favorable action on it, the idea has been "sold," in the broad, modern sense of the word.

Many methods of waking up the membership will occur to the wide-awake society official. If he will forget the "duty to the association" idea, work up good programs and "sell" them to the members, he will be successful.

## The St. Lawrence Development

THE movement on foot for the development of the St. Lawrence River to allow ocean-going vessels to enter the Great Lakes is of especial interest to the engineering world. The plan includes the building of two and ultimately three dams across the St. Lawrence and the erection of a hydro-electric power plant at these dams. A conservative estimate of the power thus rendered available is four million kilowatts.

The cost of the entire construction of waterway, dams and power houses will be less than two hundred and fifty million dollars. The sale of electric power at rates substantially under present rates will meet all interest and sinking-fund requirements.

The development of this project should have a tremendous effect upon the industrial life of the New England and Middle Atlantic States, and the yearly coal saving that would be effected has been estimated as close to forty million tons.

It has been suggested that the problem of control could be handled by an international commission without the investments of either Canada or the United States being jeopardized. The St. Lawrence River development, so Herbert Hoover has stated, is the greatest single step toward industrial efficiency ever undertaken in this country.

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In sending out questionnaires to bituminous coal consumers the Government is taking a step that deserves the enthusiastic co-operation of coal buyers everywhere. Those to whom this questionnaire is addressed should not feel that they are being asked to do something for someone else; for they themselves will be the ones to reap the greatest benefit from the publishing of the final figures. If it develops that the stocks of coal on hand are large, then consumers will know that there is little cause for anxiety on the ground of a possible coal shortage, at least until the end of next March, when there may be trouble with the miners. If it develops that there is very little coal on hand, consumers will thereby be given a valuable warning that they will do well to act upon. If the Government does not receive co-operation, and the resulting figures are incomplete, the consumers will have only themselves to blame

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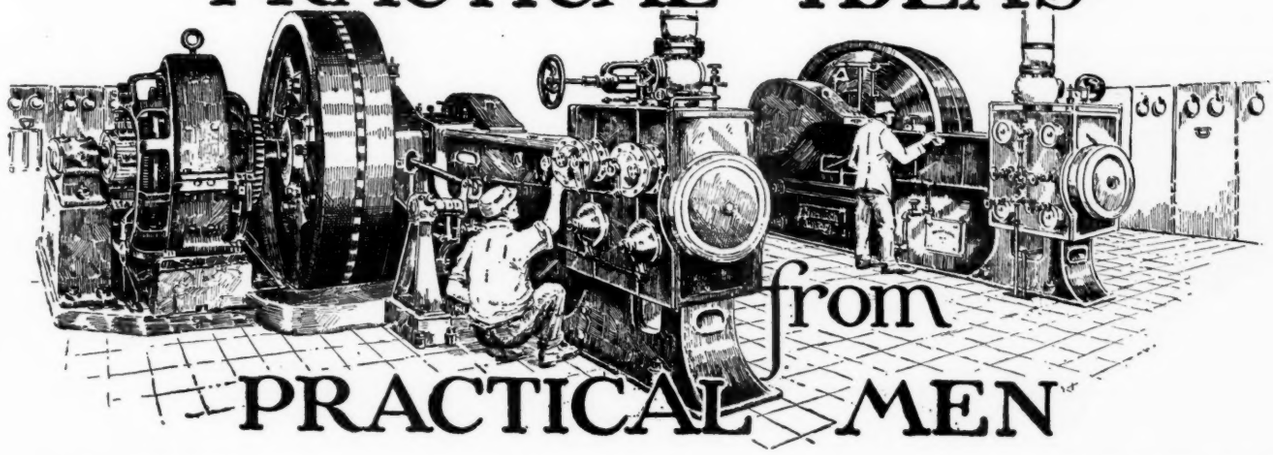
Power subjects are assuming increased importance in the A. S. M. E., as will be seen from the program on another page of this issue.

# PRACTICAL IDEAS from PRACTICAL MEN



## Tube Trouble from Dirty Feed Water

Many times mysterious failures result from neglect of the simplest things. A good example of this is evidenced by the experience of a large manufacturing company operating its own heating plant, which consisted of two longitudinal-drum boilers equipped with horizontal baffles.

The log of trouble on these boilers was as follows: Dec. 22, 1918, boiler No. 2 washed out; Dec. 23, boiler No. 1 washed out; Jan. 10, 1919, four tubes failed in boiler No. 2; Jan. 14, washed out No. 1; Jan. 15, eleven tubes failed in No. 2; Jan. 25, four tubes failed in No. 1; Feb. 1, nine tubes failed in No. 1; Feb. 4, twelve tubes failed in No. 2, and seven were rerolled; Feb. 8, one tube failed in No. 1, and five were rerolled; Feb. 12, one tube failed in No. 2, and thirteen were rerolled.

On Feb. 15 I arrived upon the scene and found that all tubes had failed in the bottom row except two, and two rows were being taken out from the bottom.

External inspection of boiler No. 1 revealed the furnace in excellent condition, showing no sign of excessive temperatures. The baffles were in good condition. The two lower rows of tubes sagged, but showed nothing to worry about. Soot was piled up on the lower baffle at the front water leg. The valves on the soot blower headers were leaking. Most of the small drain holes in the soot-blower headers were open on the top instead of on the bottom. Therefore, water was draining down on the inside water legs and running off on the tubes.

Internal inspection of this boiler was made after waiting a long time for the water to drain out. In fact, it was draining out so slowly that I knocked in some handhole plates in the second row from the bottom in the rear end, so as not to disturb anything that was lying in the bottom of the rear water leg. After the water was drained out, I found that the drain pipe was stopped up with extremely fine sediment. It was as fine as flour and packed like quicksand. The bottom of the rear water leg had an accumulation of this fine sediment all the way across the leg, up to and covering one-half of the bottom row of tubes. The ends of the tubes at the rear legs were half filled with this sediment. However, there was very little scale in this row. The second row of tubes had considerable scale, as well as an accumulation of mud. One was almost choked and several were about half-choked with scale and mud. In the third row the tubes were not nearly so bad as the second, and from there up little scale was visible. In a section up through the middle of the rear leg I removed several handhole plates, and each tube had from ½ to ¼ in. of mud in it, the amount decreasing from the bottom up. The front end of the boiler was cleaner than the rear.

Before I arrived on the scene, they had run out enough water so that they could get inside and wash the mud drum. The engineer in charge of the boilers claimed that the mud drum was generally full of mud; that it could not be removed by blowing off. It is evident after this inspection that tube trouble was due to the sediment brought in by the feed water. This sediment depositing on the tubes imposed heat insulation between the hot gases on the outside and the water on the inside, causing the tubes to become overheated to a point where their strength was reduced and failure brought about by blistering. It was characteristic that all the bending and blistering took place directly over the furnace.

Naturally, the first place to look for the trouble was in the feed-water system. It was found that an open feed-water heater was used, but readings showed the temperature to be between 80 and 100 deg. F. This low temperature was caused by an inadequate supply of exhaust steam. Following up this line of investigation, it was found that although practically all the steam is used for heating purposes, most of the condensate was going to waste.

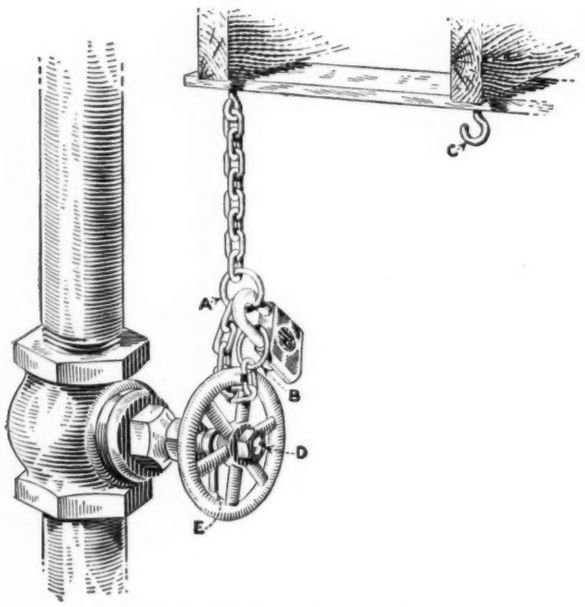
My recommendations were: First, that arrangements should be made for returning the condensate promptly to the boilers; secondly, that means were to be provided for raising the temperature of the feed water to 212 deg. F., even if it were necessary to use live steam for the purpose (the use of live steam was justified on account of the fact that the heat would cause the precipitation of the sediment; in the beginning of this treatment the boiler was to be washed out once a week, so as to follow the development of the remedy and ascertain whether the means proposed were affording an adequate protection); thirdly, that the mud drum and rear water leg be blown off frequently. In this case it was claimed that the mud would not blow off. However, there is little doubt that mud will blow off provided the boiler is blown at sufficiently frequent intervals.

The foregoing recommended procedure was carried out with a result that no trouble has since been experienced.

R. F. BURKE, Investigating Engineer,
St. Louis, Mo. Heine Boiler Co.

## Locking Device for Valves

Different methods have been suggested for locking steam valves shut or open. The plan shown will compare favorably with most of them, and the cost is small. A piece of chain is firmly attached to the ceiling. At *A* and *B* two large rings are welded in. When it is desired to lock the valve open or shut, a padlock is hooked through the rings, thus locking the chain around the rim of the valve wheel.




METHOD OF LOCKING VALVE IN EITHER OPEN OR SHUT POSITION

A hook can be placed at *C* on which to hang the chain if it is not desired to lock the valve open. The valve stem nut *D* should be riveted. If the valve stem moves in and out when opening and closing, a band *E* can be fastened to the stem, showing whether the valve is open or closed.

JAMES E. NOBLE.

Portsmouth, Ont., Canada.

## Tests of Welded Tanks

Recently, tests of welded tanks were started, but were not finished because of the weakness of the pump that was used to produce the hydrostatic pressure, and it has been necessary to build a new pump. These tanks were gas-welded with nickel steel, using a double V with a longitudinal seam and a single V for the dished heads. They were 24 in. in diameter, 6 ft. long and were made of ½-in. material that has a tensile strength of from 48,000 to 52,000 lb. per sq.in. The ½-in. heads were dished to a radius equal to the diameter of the shell and were concave to the pressure. The working pressure for these tanks, using a factor of safety of 5, is about 400 lb.

At 800 lb. test pressure, while the pressure was on, the welds were all hammered with an 8-lb. sledge, and there was no evidence of distress. At 1,200 lb. the scale on the flanges of the heads cracked in the direction of Luders lines. At 1,500 lb. the yielding pressure was reached and the tank began to take a permanent set. At 1,850 lb. or about that, varying somewhat in different tanks, the test was discontinued because of the lack of capacity of the pump, but up to this point there was no sign of distress in the welds. The heads had bulged ⅞ in. The shell had increased in circumference at the center about ¾ inch.

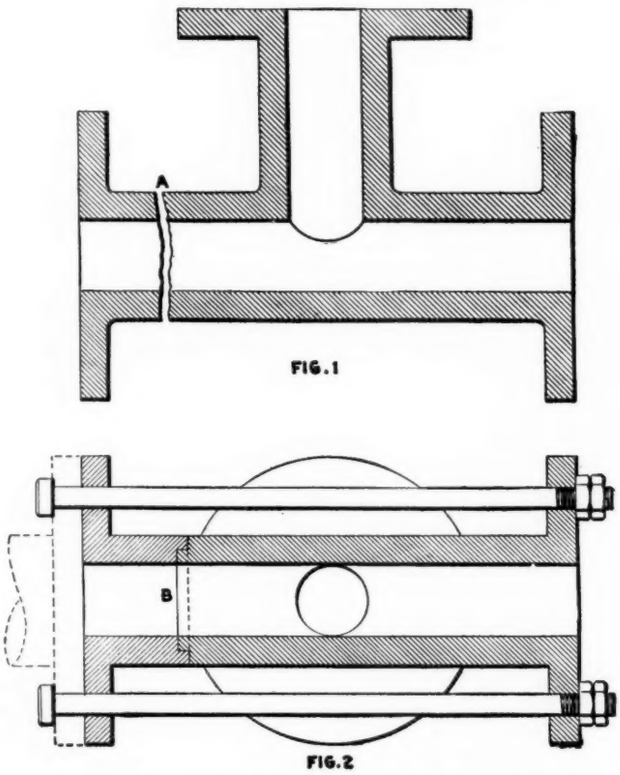
There were only three precautions taken in welding these tanks: The material was of low tensile strength, the weld rod was of nickel steel, and the longitudinal seams were welded with a double V. These tanks will be tested to destruction, and I am convinced that by using these precautions, perfectly safe welded pressure vessels for any purpose can be made in sizes to suit almost all ordinary purposes.

S. W. MILLER, M.E.,
Rochester, N. Y. Rochester Welding Works.

## Repaired Fractured Steam Fitting

In a piping system that supplied low-pressure steam, the left-hand flange of a large 12-in. cast-iron tee piece was badly fractured, as shown at *A*, Fig. 1. Not having a space casting in stock and being unable to shrink a new wrought-iron flange on owing to the position of the break, the repair to the fitting was made as follows:

The tee was removed from the pipe line and taken to the shop, and the broken portion nearest the tee outlet was faced in a lathe. A recess was then bored out to form a joint. A companion piece with the flange attached was cut from a spare length of piping, and the end of this was also bored in the lathe in a similar manner to mate with the broken tee piece, as shown at *B*, Fig. 2. Four long bolts were then made and provided with locknuts. A gasket ring was placed in the joint and the whole pulled up tight by inserting and screwing up the four new bolts, as illustrated, thus effecting a temporary repair until a new casting could be obtained.



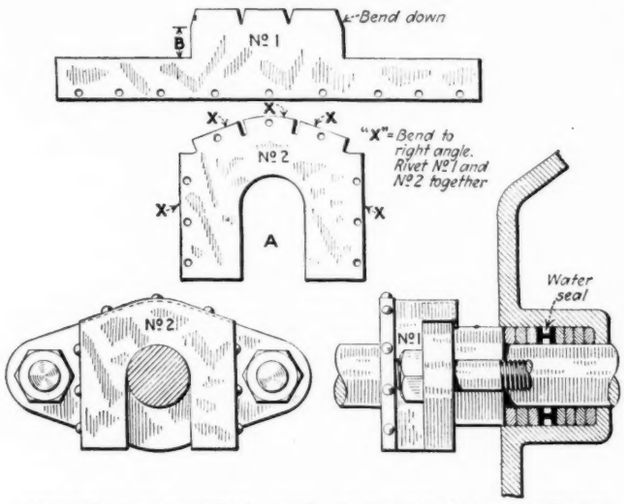

FRACTURED TEE AND HOW IT WAS REPAIRED

FRANK BRADSHAW.

Birmingham, Eng.

## Shield for Centrifugal Pump-Shaft Gland

A water shield, of which I have made several, all of which have given good results, is shown in the illustration. It is designed for use on the glands of centrifugal pumps to prevent the water that leaks from the glands from being thrown out on the floor. The length *A* should be such that it will fit easily between the stuffing-box nuts. The length *B* should be equal to the




DETAILS OF SHIELD AND APPLICATION TO SHAFT GLAND

thickness of the stuffing-box gland. The rim dimension will be determined by the size of the pump. The gland can be adjusted with the shield in place. The shield can also be removed while repacking the pump shaft.

Richmond, Ind. C. D. DISPENNETTE.

## Elimination of Side-Wall Clinkers on Underfeed Stokers

Clinkers on the furnace side walls have always been troublesome in furnace operation and were not eliminated when the underfeed stoker was developed to burn high-ash coals such as we have in the Middle West. Many such coals have ash of comparatively low fusing point.

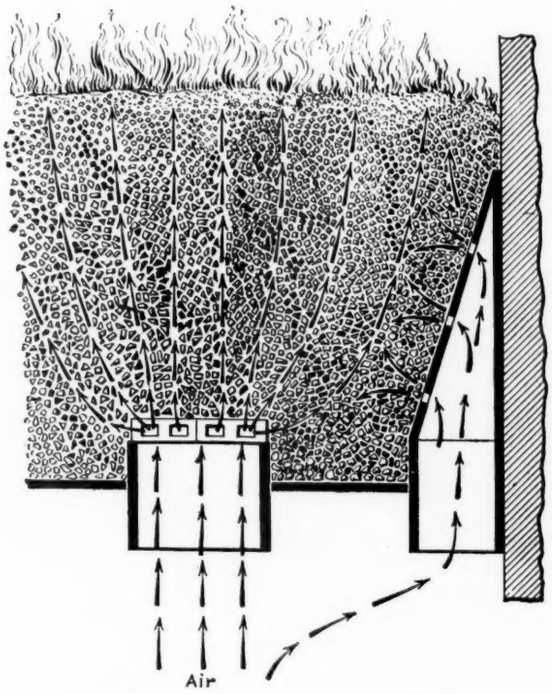
Side-wall clinkers, after being formed, grow with more or less rapidity according to the type of coal and, if let alone, will become of such size as to impede the movement of the coal on the grate. This growth is rapid with Western coals and slower with Eastern coals, but with any bituminous coal formation of clinker is expensive. As these clinkers must be removed at least once, and generally several times a day, there is excessive wear and tear on the side-wall brick as well as additional labor cost. Elimination of side-wall clinkers is now possible by two methods—treating the clinker already formed, to make its removal easy, and preventing the formation of clinker.

The former method has been in use for several years, the general idea being to emit air through hollow tile or other surface, at the line of clinker formation, so as to chill the clinker and make it so brittle that it breaks off easily. This method, so long as the air-emission holes remain open, accomplishes the desired result, but with the evident possibility of the use of excess air. The material used in the wall in most cases has never been sturdy enough to last with the firebrick and must be renewed often. Clinkers are generally easily removed, but the saving is not so great as one might hope for.

The second method has probably been conceived for many years, but no practical application was developed until a little over two years ago. It has been a success from the start and seems to be very effective. In this case the lack of air is used to produce the desired result. This is done by redesigning the tuyeres along the side walls so that the air emitted by these is into the center of the fuel bed instead of through it as with the regular type tuyeres. The section through the furnace shown illustrates the idea.

As indicated, there is no blast of air through the coal along the side walls. As the coal next to the wall does not ignite until it is almost to the dump grates, or clinker grinder, there can be no formation of clinkers on the surface of the wall. The coal is not wasted, as there is plenty of time for this small amount to burn when it gets on the dump grates or over the clinker grinder.

This idea has been developed by a leading stoker manufacturer as an improvement on the present design of underfeed stoker. The improved tuyere is adapted by removing the old tuyeres from the tuyere box next to the wall and bolting the new one to straps placed inside the box. The improved tuyere is made in several




APPLICATION OF IMPROVED TUYERE

sections, one part being bolted to the tuyere box, and the others, the ones exposed to the fuel bed, are removable so as to be easily replaced in case of their burning out. It is not necessary to change any part of the structure of the stoker.

The adoption of apparatus such as described, has been rapid in the West, but the Eastern plants have looked upon it with considerable skepticism. Where side-wall clinkers make necessary the employment of two or three extra men to assist in their removal, as in the West, it can easily be seen that the improved

tuyere will pay for itself in a short time, but where the clinker trouble is not great enough to make extra labor necessary, it is more difficult to see why one should invest in the improved tuyere. The return on the investment in the East is certainly not so great as in the West, but the savings seem to warrant such an investment. It has been found that by eliminating the strenuous manipulation of the slice bar along the side walls, the life of the walls is at least tripled. This amounts to a considerable saving in any plant.

Many Eastern plants pay a premium to the coal producers in order to get coal containing ash of a high fusing point and in low percentage. Obviously, this premium can be saved when clinkers are prevented from forming regardless of the grade of coal burned.

When the improved tuyere was placed on the open market a few months ago, many claimed that its use would cause additional excess air in the furnace. Systematic gas analyses were made in some of the Eastern plants to determine the effect on excess air, and it was found that excess air was reduced rather than increased —in fact, enough to increase the combined boiler, furnace and grate efficiency from 1 to 1½ per cent. This is partly due to the fact that leakage of air between the fuel bed and the wall is eliminated by changing the direction of the blast through the side tuyeres.

The maintainance in the West has been, so far, about the same as that of other stoker parts exposed to the fire. No replacements have been yet reported in the improved tuyere installed in Eastern plants. The hardest service that this tuyere must stand is that of a thin banked fire where hot coal is in contact with the metal and there is, of course, no air passing through the tuyeres to keep it cool.

When using the improved type of tuyere the fire must be kept heavy enough to cover the top of the tuyere by four to six inches. Some care is necessary when starting up from a "thin bank," as a sudden blast of air will blow the final coal away from the side of the tuyere and make it difficult to build up the fire properly. With these exceptions the firing methods are no different from those used with the side tuyeres now commonly in use.

HUGH R. CARR.

Philadelphia, Pa.

## Employment Advertising

When an employer is faced with the necessity of securing a man to fill an electrical or mechanical position, he usually thinks of three avenues from which he may obtain information: First, of some man of his acquaintance who may qualify for the position; second, he may seek a friend whom he thinks may know of an available man; third, he may refer his needs to the "Searchlight" section of a technical journal. Usually, the employer thinks of these points in the order named, whereas they should be reversed, since information gained through this last method is, by virtue of its nature, much slower in giving results, therefore time can be gained by starting inquiries, then following up the other two channels. Very often, a want advertisement is placed without any thought in regard to those already displayed. Such a person may not care to spend the time required for proper investigation. It is here that the "Searchlight" editor can be of assistance. When he receives a "Position Vacant" advertisement, in his reply he should inclose clippings taken from previous issues of the journal about men seeking a job similar to the one available. It may be that this is being done by some, but in my own experience with several technical journals, such assistance has occurred but once.

Dissatisfaction results very often from an employer's neglect to answer an application for a position. Obviously, from his point of view, there may be many reasons for this—he is too busy, too many replies to his inquiry, replies too vague, lack of appreciation of qualifications required, poor impression imparted through general import of the letter, etc. There are some employers who are too busy, but there are more of them that are indifferent. There are those who believe they are too busy, but who could, by self analysis, materially reduce the time actually used in daily work, but again they may say, "What is the sense in answering all these letters?" There are two good reasons: First, greater possibility of getting the right man for the place; and second, affording satisfaction to the person who has replied to the advertisement.

The following illustration will show a proper manner of handling the work of securing a man to fill a position: An employer received fifty replies to an advertisement, placed in two technical magazines, in an endeavor to find a man to fill a position as foreman. The work of handling the matter was reduced by the use of form letters. As the replies came in, they naturally divided themselves into certain classes, so some one of five different forms handled every type of application. Some of these forms courteously told the man why he could not fill the position; other forms sought further information, such as recommendations; another form left the matter open pending further investigation and conclusions. After all the information sought had been received, a selection of three men was made for personal interviews. These men were told to report at the company's office at the same time and at its expense. In this way the men met one another and each knew what the others were there for. It gave them that element of expectation and competition altogether interesting. After the required conferences had been held before three executives, a selection was made of one of the men.

The advertisement required recommendations, but in most of the cases they were not forthcoming. The publisher can be of assistance in suggesting in a clear manner on the "Want" page that copies of recommendations be sent in, without exception. At the present time, they may state that whatever recommendations are sent in, they should be copies and not originals. Also, additional suggestions might be apt, such as, if the applicant thinks that a more suitable recommendation could be had if his former employer had knowledge of the actual requirements of the particular position in mind, he write to him seeking such a letter. These suggestions should assist in bringing the transaction to a successful and prompt conclusion.

As a summary, advertisements of men seeking positions or vice versa should be concise and clear. Employers should give sufficient consideration to letters of applicants. By systematizing this work, there is greater possibility of a successful conclusion, besides giving the applicants a more satisfactory feeling. The advertising editor for the want column can be of greater mutual benefit by making certain pertinent suggestions, printed on this want advertisement page. The result should be the hiring of a good man in the shortest possible time after his need has manifested itself.

Ludlow, Mass. P. A. PACKARD.

# CORRESPONDENCE

## Engineer or Engineman?

The article by Mr. Jessup in the Oct. 25 issue brings out the attitude of a great many power-plant operating men. It is a peculiar fact that of all the branches of engineering, the steam-engine operator is the only non-technical branch in which the term engineer has been preëmpted by the practical operator. There are doubtless many reasons for this, but I believe it mainly lies in the fact that in the early stages of the art the men who designed and built the apparatus, in many cases, also operated them. This was necessary with the crude machines of the day in order to keep them going. These men were truly engineers and were comparable with the most eminent engineers in other lines.

The world has progressed, and much of our so-called plant design has been standardized to a point where it is entirely possible for a man of ordinary ability, with a practical experience in operating plants, to build a plant that will work. Whether this man is capable of making the necessary studies to determine if the machinery best fits the particular requirements, if it will require the least capital outlay consistent with the requirements, and if it will operate at the highest practical efficiency, is an entirely different matter. This, in my opinion, will largely determine the difference between the engineer and the engineman.

In civil engineering we have surveyors, bridge designers, etc., who handle the design and construction of structures of considerable importance and who would hesitate to call themselves engineers. In electrical work the chief electricians of some of the larger industrial companies go far into the technical end of the designs and handle installations of considerable size. These same men would hesitate to call themselves electrical engineers. Similar matters are handled in other branches by designers, draftsmen, foremen, etc., who do not necessarily claim the title of engineer.

It is true that in engineering, as in other lines of work, the men of real ability are not necessarily in charge of the work. Injustices occur in all lines and minor positions must be filled. It is beside the question to point out that some important positions are really held by the subordinate and not by the man who gets the credit. Andrew Carnegie made the statement, "It is cheaper to buy brains than to have them." This is the principle upon which a great many reputations have been built; but a success of this kind precludes the ability to select the proper subordinates, to select the best of their ideas for use and to handle the organization in a manner to avoid petty jealousy and friction. This demands executive ability of a high class.

The word engineer is probably too well entrenched in the ranks of the steam-power-plant operators to be withdrawn for a long time. If technical or professional engineers wish to make a distinction, it would probably appear best for them to change and adopt the French term of "Ingenieur," which would be distinct and probably reflect the "man of ingenuity" in a more clear manner to the general public. T. H. ARNOLD.

El Paso, Tex.

## Effect of Lengthening and Shortening Corliss Governor-Valve Rods

Replying to P. A. Upham's inquiry in the Oct. 11 issue, I submit the following: It is evident that the prime effect of lengthening the long governor rod and shortening the short one depends on whether the valves rotate to the right or to the left on opening. Obviously, the case in mind is that where the dashpots are inside the valve stems and the head-end valve rotates to the left for a right-hand engine and conversely. The immediate result would, therefore, be the lengthening of the cutoffs. For the same load and steam pressure the speed would increase, causing the governor to rise in an attempt to keep the speed constant.

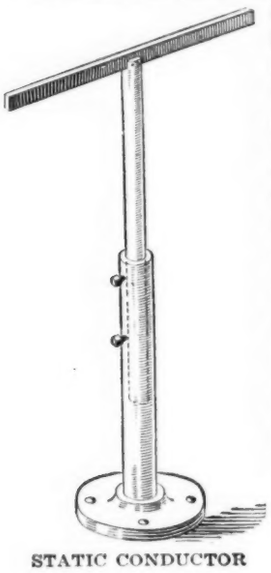
In the ideal case the speed and cutoff would be the same as before; in the actual the speed would be slightly higher and the cutoff slightly longer. The ideal governor would rise as far as necessary to keep the speed constant. It would rise from the bottom to the top of its working range for a zero increase of speed. The actual governor has a higher and higher position for each added revolution per minute. The very fact, therefore, that the governor must rise higher than before means higher speed and longer cutoff, as the governor attempts to bring them to the same values as before for a constant load.

Of course the adjustment is to secure proper maximum cutoffs, and their equality at the desired load. They are adjusted to give the maximum cutoff usually with the governor in the starting position; that is, the valves will trip just before the wristplate and eccentric reach extreme travel. One of these is permanent while the other must be changed for equal cutoffs at the rated load, or usual load if it is more desirable. The governor is blocked to the point corresponding to this load, or this load is put on. The longer cutoff must be shortened and adjusted to give equality. This may be done closely by measurement, while if done by the indicator equal power distribution is assured under operating conditions. A. R. NOTTINGHAM,

Pullman, Wash. Assoc. Prof. Steam Eng.

## Remedy for Static Electricity

Static electrical discharges from belts, such as trouble C. N. Peterson, page 651 of the Oct. 25 issue of *Power*, can be remedied by using the means as illustrated. First, get a floor stand such as is used with guard rails and screw in a suitable length of iron piping that has been tapped for two capscrews as shown. Another piece of pipe, or a rod if more convenient, is used to make a sliding fit inside the larger pipe, and of a length to meet the particular case. Across one end of the smaller pipe secure a rod 12 in. in length, or longer, of either brass, copper or steel as shown. This arrangement will carry away the static charges if the base is grounded.



STATIC CONDUCTOR

T. A. LAWSON.
Trenton, N. J.

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I would suggest the use of a small copper wire, one end of which should be grounded, the other end to lie at right angles to the belt as it passes over one of the pulleys, and a distance of about ⅛ in. from the belt. This arrangement worked very satisfactorily for me a few years ago.

Hoboken, N. J. FRED W. FERSON.

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In the Oct. 25 issue Mr. Peterson asks for a remedy for static electricity on a belted lineshaft drive. Static charges on belts are largely caused by friction from belt slippage and are particularly annoying when all parts are very dry.

The first remedy is to reduce the slippage as much as possible by applying belt dressing or tightening the belt. This will not only reduce the slippage, but also increase the life of the belt. In case this does not entirely remove the trouble, the metal parts should be thoroughly grounded. The engine will probably be grounded through the steam and exhaust lines. If the lineshaft is mounted on dry wood supports, it may be necessary to connect a wire from one of the bearing housings to a water pipe or to the building steel to dissipate the charge to ground. The charge on the belt may be removed by placing a grounded wire or metal guard a short distance from the belt where it leaves the pulley. A series of sparks from the belt to the metal parts will then dissipate the charge.

Where inflammable dust is present, these sparks would be dangerous and a wiper brush would be more satisfactory. To make such a brush, remove the insulation from several pieces of lamp cord about one foot long. Take a piece of solid-copper wire or brass rod of sufficient diameter to form a rigid support and of sufficient length to span the belt. Fold the pieces of lamp cord in the middle and hang them over the rod, leaving both ends about equal. Solder the lamp cord to the rod at intervals of one inch. This will give a flexible brush which will not damage the surface of the belt. This brush should be supported so the trailing ends of the fine wire will drag on the belt as it leaves the pulley. The rod should be grounded to the engine frame.

El Paso, Tex. T. H. ARNOLD.

## What Is the Matter with the Steam Table?

In answer to J. W. Douglass, *Power*, Oct. 4, I wish to say that the apparent discrepancy in the steam table can be explained as follows, the chart shown will make the matter clear.

In order to generate steam, two things must be done to the water. It must first be heated from the temperature at which it is taken into the system to the temperature corresponding to that of the steam pressure. This requires a certain definite amount of heat, which is called the heat of the liquid ($i'$). After the water in the boiler has been heated up to this temperature corresponding to the steam pressure carried, another definite amount of heat is added to change the water into steam. This heat that is now added is called the heat of vaporization ($r$). Dry saturated steam at any particular pressure has a definite amount of heat, which is called the total heat of steam ($i''$) and is equal to $i' + r$.

If the accompanying chart is examined, it will be observed that for a pressure of 0.0887 lb. per sq.in. absolute, which corresponds to 32 deg. F. the heat of the liquid is 0, and that in order to get dry saturated steam at that pressure, all the heat that must be added is the heat of vaporization, which is 1,073 B.t.u. (Goodenough's Table). These points are shown on the diagram by *A* and *B*. From zero pounds absolute up to

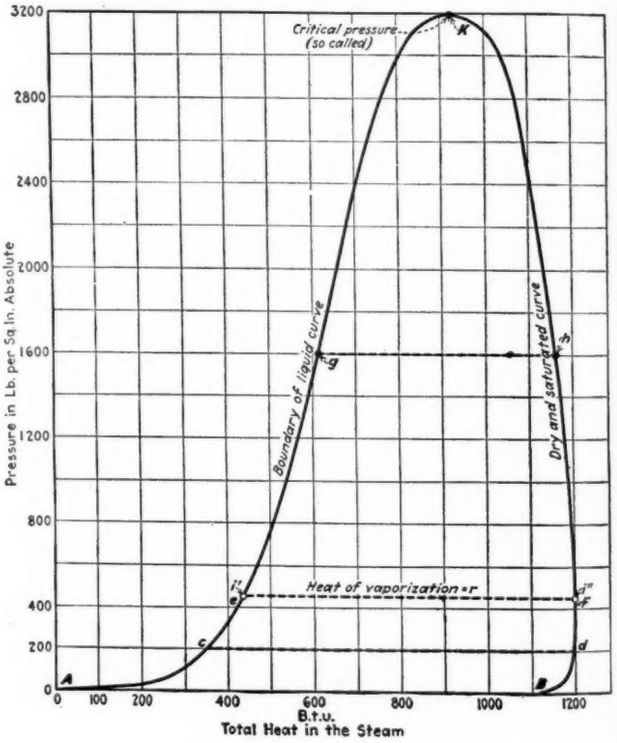


CHART OF HEAT OF STEAM

200 lb. per sq.in. absolute the total heat of steam increases very rapidly, but it will be noted that the heat of the liquid increases while the heat of vaporization decreases slightly. At 200 lb. per sq.in. absolute $i'' = 1{,}198.5$ B.t.u. and is made up of $i' = 3{,}545$ and $r = 844$. Up to 450 deg. F., or 421.7 lb. sq.in. absolute, the heat of the liquid increases faster than the heat of vaporization decreases, and at that value dry saturated steam contains the maximum amount of heat; that

is $i''$ 1,202.5 B.t.u. (point *F* on the chart); $i' = 427.7$ and $r = 774.8$ B.t.u. From 450 F. up the heat of vaporization decreases faster than the heat of the liquid increases, and therefore the total heat of the steam decreases. At 1,600 lb. sq.in. absolute, $i''$ is 1,160 B.t.u. and $i'$ 615 B.t.u. as shown at *h* and *g* on the chart. At 3,200 lb. sq.in. absolute, or 706.3 deg. F., the so-called critical pressure is reached, and at this point the heat of vaporization becomes zero, and the total heat of the steam is represented by the heat of the liquid. It is equal to 921 B.t.u. per lb. and represented by point *K* on the chart. In all steam tables the heat is measured from 32 deg. F., and therefore we find the tables giving the heat of the liquid at that temperature as equal to zero.

L. SEELIG.

Urbana, Ill.

## Advantage of Nitrogen in the Boiler Furnace

I decidedly disagree with the author of "Advantages of Nitrogen in the Boiler Furnace," page 647 of the Oct. 25 issue of *Power*, for I believe that if a practically unlimited supply of oxygen were available at the cost of moving it, as air is, it would allow of high economies in first cost of boilers and to a less extent in operation. In the blast furnace it is already, or just about to be, a paying proposition to use a larger percentage of oxygen on account of the increased capacity and improved quality and uniformity of the product, and also because of the more expensive coke required for fuel. The boiler is a much larger user of the cheapest possible fuel, so that until other conditions change to make the cost of enriching the air in oxygen or using pure oxygen relatively less compared with the possible saving in fuel, it will have to wait.

Of course, combustion with pure oxygen would increase the fire temperature enormously, but as the most reliable investigations show the mean specific heat of carbon dioxide at 3,000 deg. is nearer 0.30 than 0.20 and still increasing, these temperatures would probably not be uncontrollable, as many of the present features of blast-furnace design could be adopted, such as water-cooled tuyeres, tapping out the ash melted down to slag, with the addition of small quantities of flux or by a judicious mixture of coals to give an ash of the desired fluidity, etc.

The firebox of such a boiler would have to consist of water-cooled surfaces, but this could be arranged by means of tubes closely spaced, if necessary in a double row; and owing to the high rate of conduction into the tube metal from the radiant heat of the fire, the gases would be reduced to a temperature approximating that of present boiler practice before entering the passes of the boiler.

Practically no limit has been found to the absorption of heat from the tubes by the water in the boiler, provided circulation is maintained, and by making the side walls an integral part of the boiler, as is done in many of the high-capacity marine boilers, these would account for most of the evaporation. And the remaining heating surface could be materially reduced, as the heat content and volume of the gases would be only about one-fifth of what they would be with combustion supported by air.

It is a mistake to assume that an increased volume of gases will transmit heat to a boiler more efficiently, whether the entering temperature or entering total heat content of the gas is taken the same. In the first case, the temperature at the entrance being the same, the rate of heat transfer, B.t.u. per square foot of heating surface per degree temperature difference per hour, does not increase as rapidly as the velocity, and the higher-velocity gas will not be able to give up as much heat per square foot of heating surface passed over, and will therefore leave at a higher temperature, with correspondingly less efficiency. In the second case, the total heat content of the gases being the same, the larger volume of gas would be at a correspondingly lower temperature and give a lower rate of heat transfer, resulting in a greater proportion of heat carried away by the higher-velocity gases.

This is shown experimentally, as I have analyzed flue gases from a 5,000-sq.ft. hand-fired boiler equipped with flue-gas temperature recorder and found that as the fire was changed from a very white, hot fire, giving 14 to 15 per cent $CO_2$ with 0.3 to 1.0 per cent CO with a flue-gas temperature of 490 to 520 deg., to a redder, cooler fire giving 10 to 11 per cent $CO_2$ with no unburned gas, the flue temperature rose to 700 deg. F., the boiler being operated at 125 to 150 per cent rating. Also, in connection with some coal tests on a 5,080-sq.ft. water-tube boiler with mechanical stoker, the following averages were obtained for 10 hours.

| | Percentage Rating Developed | |
|---|---|---|
| | 116 | 109 |
| Flue-gas temperature, deg. F. | 541 | 586 |
| Carbon dioxide, $CO_2$, per cent | 10.4 | 8.9 |
| Oxygen, $O_2$, per cent | 9.0 | 11.3 |
| Carbon monoxide, CO, per cent | 0.6 | 0.1 |
| Nitrogen, $N_2$, per cent | 80.0 | 79.7 |
| Percentage excess air | 76 | 119 |

Steam pressure, 160 lb. gage; saturation temperature, 371 deg. F.

In these tests on successive days with the tubes blown with a steam lance just before starting, an increase of 25 per cent in flue-gas volume caused 26 per cent increase in the temperature difference between the flue gases and boiler tubes.

It therefore seems reasonable to conclude that the tube surface for the absorption of heat from the gases could be reduced to one-third if not one-fifth of that now required, with a corresponding saving in cost and space.

The heat losses in the flue gases would also be reduced, as those would be only about one-fifth of the amount with air or possibly even less as with every uncombined molecule. A molecule of oxygen combustion would be more quickly and thoroughly completed than where these are diluted, not only by the carbon dioxide already formed, but by four molecules of nitrogen for every original molecule of oxygen. As under favorable conditions the flue-gas loss from a boiler is seldom less than 13 to 14 per cent, it will be seen that four-fifths of this offers a promising field of investigation.

So, while the present developments of the art of producing oxygen do not afford much encouragement, if any unexpected discoveries should make large quantities of oxygen available as a byproduct, or at an almost negligible cost, its use in boiler furnaces would present an interesting and attractive problem.

New Haven, Conn. H. D. FISHER.

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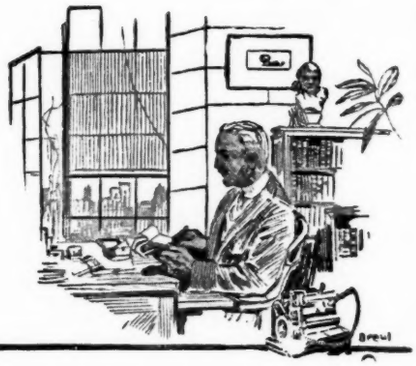
The London *Engineer* recently carried an interesting item on the electrical welding of a marine return-tube boiler of about 15 ft. diameter. The end plate and shells were welded together by the Kjellberg process, and it is stated that the boiler was absolutely tight at the first test, when 360 lb. pressure was applied. It is said also that the boiler has been in operation for nine months, and there is still no sign of leakage.

# QUESTIONS AND ANSWERS



## The D Slide-Valve Engine

What are the advantages and disadvantages of the D slide-valve engine? L. C. V.

The advantages of D slide-valve engines are cheapness and simplicity of design, possible permanency for the valve adjustment, durability and the relatively less skill required for their care and operation than for other types of reciprocating engines. The disadvatages are greater friction of the valve, thereby requiring the employment of a throttling governor with poor speed regulation for variation of boiler pressure or change of load and a reduction of power capacity of a given size of cylinder from use of a throttled boiler pressure; uneconomical distribution of steam and reduction of power from reduction of steam-chest pressure during admission and realization of less expansive force of the steam by wiredrawing due to slow movement of the valve in opening and closing; and also from requirement of lateness of cutoff necessary to prevent too great reduction of the capacity of the engine from early closure of the exhaust with excessive compression. There is also loss of economy from a large percentage of cylinder-clearance space, due to long steam passages from the steam chest to the cylinder and from condensation of live steam by the cooling action of the exhaust on the steam passages and the valve.

## Heat Given Off by Mazda Lamps in Refrigerating Rooms

In laying out a system of piping for a cold-storage room, the heat developed by the electric lights in this room must be taken care of in the square feet of cooling surface provided. In talking this over with different engineers there seems to be a great difference of opinion as to the amount of heat given off by Mazda lamps. Some allow values for the heat units given off by a 100-watt Mazda incandescent lamp as high as 1,650 B.t.u. per hour. What is the method of calculating the B.t.u. given off by different sizes of lamps? D. L. F.

Undoubtedly, the confusion of opinion on the question lies in the fact that part of the energy supplied to the lamps is given off in the form of light and part in the form of heat, and the question is what becomes of the energy converted into light? A refrigeration room has opaque, non-heat conducting walls. Therefore, the light energy emitted from the lamp would ultimately strike the walls of the room and be converted into heat. The total effect of the lamps upon the cooling system would, therefore, be exactly the amount of energy that is put into them. Mazda B (vacuum) and Mazda C (gas-filled) lamps of equal wattage give off different proportions of light and heat. In a refrigeration room, however, their ultimate effect upon the cooling system would be the same. The relation between the watt and B.t.u.'s per hour is as follows:

One watt equals 3.4136 B.t.u. per hour. From this relation we can compute the following table:

| Wattage of Lamps | B.T.U. per Hour in Refrigeration Room | Wattage of Lamps | B.T.U. per Hour in Refrigeration Room |
|---|---|---|---|
| 7½ | 25.6 | 50 | 170.7 |
| 15 | 51.2 | 60 | 204.8 |
| 25 | 85.3 | 75 | 256.0 |
| 40 | 136.5 | 100 | 341.4 |

From the foregoing it is evident that the figure 1,650 B.t.u. for a 100-watt lamp is very much in error, since it is equal to about the value for a 500-watt lamp, which is equal to $3.4136 \times 500 = 1{,}707$ B.t.u.

## Position of Engine for Keying Up Connecting-Rod Brasses

In what position should a steam engine be placed when taking up the crosshead brasses and crankpin brasses? W. F. S.

The same side of the crankpin away from the shaft receives the push and pull of the connecting rod, while opposite sides of the crosshead pin alternately impart motion to the connecting rod. In some engines the wear is greater when the crankpin is on dead center, while in others it is between the positions of dead center and when the crankpin is on the quarter. Keying up should be done with the boxes in the position which places the largest diameters of the pins in line with the connecting rod, for keying up with a smaller diameter in line would cause overheating when the largest diameter comes in the boxes to that position.

The largest diameter of the crankpin can be determined by calipering the pin or other method of measurement, and usually it will be found that the largest diameter of the crankpin will come in line with the connecting rod and the crank will be placed in proper position for keying the brasses when the crosshead stands at about three-quarters stroke from the head end of the cylinder.

## Reduction of Steam Consumption of Paper Machine From Running Damper Paper

If a paper machine takes 8,500 lb. of steam per hour at 13 lb. gage reduced from 125 lb. gage on the distributing line, and to run the paper a little damper we can get along with reduction of the line pressure to 8 lb., what would be the difference of steam consumption? E. E. S.

The quantity of steam used must be based on the B.t.u. per pound weight of steam supplied multiplied by the number of pounds used. Assuming that the dis-

tributing line supplies dry saturated steam at 125 lb. gage, or 140 lb. per sq.in. absolute, then according to the steam tables each pound weight of the initial steam would contain 1,192.2 B.t.u. When passed through a reducing valve and throttled to 13 lb. gage or any other pressure, each pound (weight) of the steam still would contain the same amount of heat, namely, 1,192.2 B.t.u. According to the steam tables if a pound of steam at 13 lb. gage contains 1,192.2 B.t.u. it would be superheated and would have a temperature of about 308 deg. F., and when reduced to the pressure of 8 lb. gage, or 23 lb. absolute, the steam would have a temperature of 305.5 deg. F.

The rate of drying or evaporation of moisture will be slightly greater at the higher temperature, but for practical purposes, the rates may be regarded as in proportion to the temperatures; and as the quantity of heat used per hour by the drying process is directly as the rate of evaporation, the steam consumption per hour with reduction of pressure to 13 lb. gage would be to the consumption per hour with reduction to 8 lb. gage as 308 to 305.5. That is, when running damper paper with the steam reduced to 8 lb. gage, the consumption of steam per hour would be about 1 per cent less than when reduced to 13 lb. gage. Hence, if 8,500 lb. of steam is required per hour when the supply is used at 13 lb. gage, to use the steam reduced to 8 lb. gage the consumption would be reduced about 85 lb. per hour.

### Returning Condensate to Boiler by Gravity

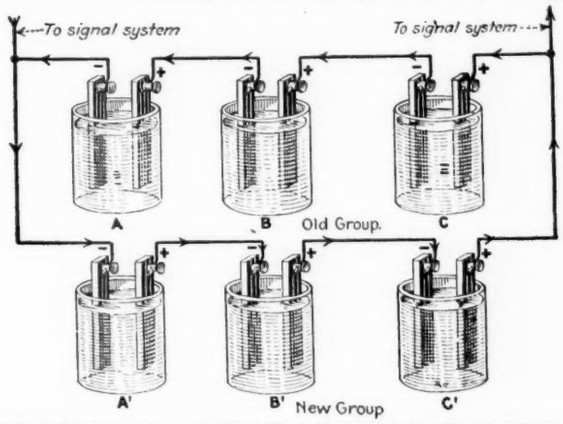
Our laundry is equipped with several ironing and pressing machines and dry rooms, all of which are supplied with steam at boiler pressure. The condensate from the machinery and dry rooms is received in separate traps which discharge to a return trap that returns the condensate to the boiler. As the dry room and all machinery are 20 ft. above the boiler, would it not be better to remove the traps and return the condensate to the boiler by gravity? C. E. H.

Gravity return of the condensate is possible only when the pressure in the machine or coil, plus the pressure due to the head of water in the return pipe is greater than the pressure required for overcoming pipe friction, plus the pressure in the boiler. When the coils and machinery supplied with steam are 20 ft. above the water line of the boiler, the pressure due to the head of water in the return pipe at the boiler-water level would be $20 \times 0.433 = 8.66$ lb. per sq.in. Neglecting loss of pressure due to friction in the return pipe, the water could not be returned to the boiler by gravity for any pressure in the steam spaces of the machines or heating coils if more than 8.66 lb. per sq.in. below the pressure in the boiler. For instance, if the boiler pressure is 60 lb. per sq.in. and the loss of pressure for overcoming the friction of flow in the return pipe is 1 lb., then the lowest pressure that could be maintained in the coils or machines and effect a return by gravity would be $60 - (8.66 + 1) = 50.34$ lb. per sq.in. gage pressure.

It might be possible to maintain dry room coils with less drop of pressures, but for ironing machines, etc., it would be impracticable to depend on so little reduction of pressure, from the fact that steam-heated machinery usually is designed to have the supply modified by throttling the steam at the supply valves, according to the room temperature and the amount of heat required for satisfactory operation. Very frequently in steam-heated machinery of this kind, the actual operating pressure is so much lower than the boiler pressure that 20 ft. drop to the water level of the boiler does not afford enough additional pressure to overcome the pressure of the boiler and, for certainty of operation of the machinery, it would not be advisable to dispense with the traps and depend on returning their condensate by gravity, although that may be practical for the dry room coils.

### Batteries on Elevator Signal System

On one of our signal systems three battery cells are connected in series. The system failed to operate and another group of three cells in series was connected across the terminals of the old group, as in the diagram. This worked out satisfactorily for a short time, and then the system went dead again. Did not the grouping of the new cells with the old ones have something to do with the shortening the life of former? E. A. W.




TWO GROUPS OF BATTERY CONNECTED IN PAFALLEL

The old cells, being of a lower voltage than the new group, acted as a circuit for current from the new group to flow through. Assume that voltage of the old group was 3 volts and that of the new 6 volts, and the internal resistance of each group is 0.5 ohm. Now the six volts from the new group will cause a current to flow from the + terminal of cell $C'$ into the + terminal of cell $C$ through the old group to the — terminal of cell $A'$ and through the new group as indicated by the arrowheads. This current flows through the two groups in series, therefore the resistance of the path will be that of the two or $0.5 + 0.5 = 1$ ohm. The 6 volts from the new group is opposed by the 3 volts from the old group, consequently the voltage effective in causing the current to flow is the difference between the two, or $6 - 3 = 3$. This gives a condition where we have 3 volts causing current to flow through a circuit of 1 ohm resistance. The current in amperes equals volts divided by resistance, in this case $3 \div 1 = 3$ amperes. If the conditions are as assumed, then when the two groups of cells were connected in parallel the new group would supply 3 amperes to the old one, which in a short while discharged the former. In no case should new battery cells be connected in with old ones.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

## Power and Fuel Waste—Two Big Topics for the A. S. M. E. Annual Meeting

Power problems are to come in for a large share of attention at the annual meeting of the American Society of Mechanical Engineers, which will be held Dec. 5-9 in the Engineering Societies Building, New York City.

For some time it has been known that the elimination of waste in industry was to be the keynote topic of the meeting, but only upon release of the final tentative program has it been understood that the prevention of waste of fuel and power is to be so prominent a feature of the meeting. This is well brought out by the fact that there are fourteen features on the program having a direct bearing on the subject of power. These features are: four heat-balance papers; two gas-power papers; a trip to a power station; four fuel papers; "movies" of stoker operation; a paper on boilers, and one on condensers.

The program follows, including only brief references to topics not of interest to power-plant men.

### Monday—The First Day's Activities

After registration the morning will be given over to a council meeting and a local sections conference. There will also be a public hearing on the Boiler Code Committee's new code for air tanks and pressure vessels, at which all who are interested have been invited to give their opinions. In the afternoon there will be the leading session on the Elimination of Waste in Industry, the details of which have not been announced. In the evening there will be a session on Education and Training in the Industries, with papers by Dean R. L. Sackett and D. C. Buell.

### Tuesday—Heat-Balance Day

The big event on Tuesday will be the Power Waste Session, which will take up the whole morning. It will be in the nature of a "Heat-Balance Symposium" and will comprise four papers on the heat balance of the following stations: Connors Creek Station of the Detroit Edison Co., by C. H. Berry and F. E. Moreton; Colfax Station of the Duquesne Light Co., by C. W. E. Clarke; Delaware Station of the Philadelphia Electric Co., by E. L. Hopping; Hell Gate Station of the United Electric Light and Power Co., by J. H. Lawrence and W. M. Keenan. At 10 a.m. there will be a public hearing on the proposed code for miniature boilers. Simultaneously with the Power Waste Session there will be a Machine-Shop Waste Session and a Railway Session.

In the afternoon gas engines will be the topic, there being planned a Gas Power Session, with two papers: "Porting and Charging of Two-Stroke Oil Engines," by Louis Illmer; "Compounding of the Internal-Combustion Engine," by E. A. Sperry.

For simultaneous sessions there will be the Forest Products Waste Session and the Management Waste Session, in the latter of which papers will be given by W. N. Polakov and F. B. and L. M. Gilbreth.

There will also be excursions to the plant of the Seaboard By-Products Co. and to the Essex Power Station of the Public Service Company of New Jersey.

The day will be closed with the presidential address and reception, when honorary fellowships will formally be conferred on Henry R. Towne and Nathaniel G. Herreshoff.

### Wednesday—Business Day

Business meetings will take up both morning and afternoon on Wednesday, and there is much to be considered and settled. Most important will be the discussion of the new constitution and the amendment concerning the junior members' vote.

The ladies' tea and reception in the afternoon and the informal get-together smoker in the evening will round out a day of general popular interest.

### Thursday—Fuel Waste Day

The four papers in Thursday morning's Fuel Waste Session are as follows: "Boiler Plant Efficiency," by Victor J. Azbe; "Fuel Saving in Relation to Capital Necessary," by Joseph Harrington; "Developments in Boiler and Furnace Design," by D. S. Jacobus; "Producer Gas for Industrial Furnaces," by W. B. Chapman.

Simultaneously there will be a Research Conference, a Materials Handling Waste Session, a Student Session and a General Session. In the latter, two papers will deal with stresses in cylinder heads and the control of centrifugal castings.

Professional Engineering Education for the Industries will be treated in the afternoon in a joint session with the Society for Promotion of Engineering Education. At the same time R. Sanford Riley will present moving pictures showing "close-ups" of stoker combustion. In the evening the society buds will blossom forth in a dinner dance at the Hotel Astor.

### Friday—The Last Day

The Second General Session will attract power-plant men on Friday, because of two papers: "Testing of Emergency Fleet Boilers Using Oil Fuel," by F. W. Dean; and "Steam Condensing Plants," by Paul A. Bancel.

Simultaneous sessions will include the Aeronautic Waste Session, the Textile Waste Session and the Ordnance Waste Session, followed by a council meeting. Those remaining for the afternoon will be offered an inspection trip through the veteran troopship "Olympic." College reunions will end the day and the convention.

### Necessary Details

Information about the meeting may be obtained by addressing the society at its headquarters, 29 West Thirty-ninth St., New York City, where the coming affair will be held. Members' registration fee will be $1; male guests will be subject to a charge of $2, from which ladies will be exempt. Attention is especially called to the fact that a reduced fare consisting of half-fare on the return trip may be obtained if members will only take the trouble of getting a certificate from the nearest Trunk Line Association that has agreed to grant the lower rate.

## Fuel Problems Discussed at New Haven Meeting of A. S. M. E.

On the afternoon of Nov. 14 the New Haven Branch (Connecticut Section) of the A. S. M. E. started a Fuel Conference, which was continued in the evening session. The two sessions, both of which were held in the Mason Laboratory of Mechanical Engineering of Yale University, were well attended by local engineers and by visitors from other parts of the state.

### The Afternoon Session

Two papers were presented in the afternoon session, the first of these, "The Mining of Fuel, its Quality and Cost," being given by J. W. Paul, of the United States Bureau of Mines. In this paper Mr. Paul stated that it was possible, by improved methods, to mine coal without losing more than 5 or 10 per cent of the available supply, although the present average loss is about 40 per cent on account of the general use of older methods of mining. Mr. Paul advocated the adoption of seasonal freight rates to prevent periodic congestion of coal shipments and to bring about a more uniform rate of coal production.

The second paper, entitled "The Transportation of Coal with Reference to Cost," was given by H. M. Payne, consulting mining engineer, New York City. Mr. Payne stated that the present prices of bituminous coal at the mine were very close to, and in some cases less than, the cost of production. He also said that, in his opinion a reduction in the price of coal at the mine was impossible until labor and materials come down. As for freight rates he felt that no reduction would be made before next summer. From this he concluded that it would be eight months at least before there could be any reduction in the price of delivered coal. Mr. Payne advised large coal consumers to provide for a supply of coal to carry them through next spring, at which time he felt there might be disturbances affecting production. Much interest was expressed in his statement

that the high cost of transportation was caused not so much by high wages of railroad employees as by working agreements inherited from the period of Government operation, which made it impossible to operate the railroads on an efficient basis.

The afternoon session was followed by a dinner in the course of which plans for affiliating the engineering societies in Connecticut were discussed. All the speakers expressed their approval of some co-operative arrangement, and the committee that had been investigating the matter was instructed to continue its work.

### Doings of the Evening Session

The evening session was a symposium on the use of coal in Connecticut. After the presentation of a paper by Prof. E. H. Lockwood, of Yale University, in which he showed how the cost of heating houses might be greatly reduced, Mr. G. E. Wood, of the Connecticut Company, read a paper entitled "Burning Bituminous Coal on Taylor Stokers." He emphasized the importance of maintaining a uniform stoker speed in order that the ash might be freed as soon as it was formed; otherwise there might be trouble with clinkers. He stated that a long and slow stroke of the plungers was preferable to a short, quick stroke. According to Mr. Wood this type of stoker should be so operated as to maintain a constant "contour," or general shape, of the fuel bed at all loads; the actual thickness would, of course, increase with the load. With a given kind of coal, he stated that it was important to determine at the outset what combination of draft and stoker speed gave the best results for each load. In this connection flue-gas analyses would be of great assistance. The combinations thus determined should be closely adhered to as long as the same coal is used. Mr. Wood then told of tests made with two kinds of coal, the first being a high-grade coal low in ash and sulphur and one whose ash had a high melting point, and the second a low-grade coal with the opposite qualities. A load of 250 per cent of rating was easily carried with the good coal, but could not be maintained with the low-grade coal. The conclusion was drawn that the coal should be carefully selected if high ratings are to be carried and that the most important considerations are low ash content and an ash of high melting point. The dividing line between high and low melting points was placed at 2,000 deg. F.

The third paper was given by P. L. Smith, of the Winchester Repeating Arms Co., and was entitled "Burning Anthracite Screenings on Chain-Grate Stokers." Mr. Smith stated that his company had, during the fuel shortage of 1920, equipped two boilers with Coxe traveling-screen stokers and had successfully burned No. 3 buckwheat at 200 per cent rating with an efficiency of 71 per cent. A load of 250 per cent rating was carried for four hours and could evidently have been continued without difficulty. On account of the temporarily high prices of the fuels that would otherwise have been used, this equipment paid for itself in six months. In the discussion it was brought out that coke braise and even yard sweepings had been successfully burned on stokers of this type.

This was followed by a paper entitled "Burning Bituminous Coal on Taylor Stokers," by C. J. Richmond, operating engineer of the United Illuminating Co.'s Bridgeport plant. Mr. Richmond gave many suggestions on stoker operation from the operating man's viewpoint. He said that it was possible in his plant to go from a banked fire to 250 per cent of rating in 14 minutes. He was able to burn as high as 60 lb. of coal per hr. per sq.ft. of grate surface. He used coal analyzing moisture 1.58 per cent, volatile 21.40 per cent, fixed carbon 71.37 per cent, ash 5.65 per cent, sulphur 1.06 per cent, and having 14,464 B.t.u. per lb. (dry). Normal operation was at 150 per cent rating with 2 to 2½ in. of draft below the fire, 0.1 to 0.2-in. of suction above it and a fire thickness ranging from 26 in. to 30 in. Mr. Richmond considered $CO_2$ recorders and flow meters as invaluable aids to correct stoker operation. For boilers having more than 10,000 sq.ft. of heating surface he favored the individual stoker drive for each boiler as permitting better control of load distribution between the boilers.

The last paper, entitled "Burning Bituminous Coal on Type E Stokers," was given by R. A. Saunders, of The Seamless Rubber Co. The stoker described was of the single-retort underfeed type made by the Combustion Engineering Co. A good quality of coal was used and high ratings had not been tried. Operation was entirely satisfactory. There was practically no smoke and the boiler efficiency as computed from the daily plant records frequently ran as high as 78 per cent.

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It is not difficult to get a simple mental picture of what the $CO_2$ analysis means. Assume that coal is nothing but carbon and that it all burns to $CO_2$; then all the coal and all the air supplied to the boiler go up the chimney. If 20 lb. of air and 1 lb. of carbon enter, 21 lb. of flue gas goes up the chimney. If a chemist should examine the 21 lb. of flue gas, he would find that it contains 3⅔ lb. of $CO_2$ and he would know that 3⅔ lb. of $CO_2$ contain 1 lb. of carbon, since $\frac{3}{11}$ of the weight of $CO_2$ is carbon, the rest being oxygen. The main point to consider is this: If the percentage of $CO_2$ in the flue gas is cut in two, it simply means that there is twice as much flue gas (and approximately twice as much air) for every pound of coal. Suppose that the standard (that is the best) $CO_2$ for a given boiler is 15 per cent, for example. The number 15 divided by the actual percentage shows roughly what fraction of the standard amount of air is being used; that is, 5 per cent $CO_2$ would mean $\frac{15}{5}$, or three times standard, while 10 per cent of $CO_2$ would mean $\frac{15}{10}$, or 1½ times standard.

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The term "balanced draft" refers to a condition in which there is neither pressure nor suction in the space just above the fire or where the amount of this pressure or suction is very small in comparison to the drop through the fire. Its chief purpose is to avoid the leakage of air through the boiler setting. To obtain a balanced draft, it is necessary to provide a forced draft below the fire sufficient to overcome the resistance through the fire. Then the suction produced by the chimney (or by the induced-draft fans, if they are used) must be so controlled that it is just sufficient to draw the products of combustion through the boiler, leaving practically no suction or pressure at a point above the fire. While it is always important to keep a tight setting, the use of a balanced draft greatly reduces the losses due to cracks and leaks.

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Domestic exports of electrical machinery and appliances from the United States in September reached a total of $4,938,700. The large amount of these exports that went to Japan is interesting, as that country took more than any other in some classifications; this was especially noticeable in the case of dynamos and generators, of which $179,087 went to Japan, as compared with $139,253 to Canada, the next on the list, the total being $855,419.

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Consumers are well stocked with coal for the winter, according to reports from different sections of the country received by *Coal Review*, which states that public utilities throughout the country have from two to four months' supply and that the railroads have about a six weeks' supply on hand. Industrial users are said to be buying slowly; it is difficult to know just what their winter demand will be.

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Bituminous coal has been selling during the fall and summer at an average price at the mine actually less than the cost of production, it is claimed by *Coal Review*, which reports the present average spot mine price as $2.37 a ton and the production cost as $2.50 a ton.

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It is expected that the Commerce Department will take an active part in the consideration of expiring coal wage agreements next spring, in case difficulties should develop necessitating Government mediation.

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In an effort to relieve the unemployment situation, the Great Northern Power Co., of Duluth, Minn., plans to continue the work of extending its reservoirs throughout the winter.

# News in the Field of Power

## Federation Council to Meet January 5

At a recent meeting in New York City of American Engineering Council's Committee on Procedure it was decided that the next meeting of the council would be held in Washington, Jan. 5 and 6. A program for the meeting is already being prepared by a committee consisting of A. P. Davis (chairman), John C. Hoyt, Philip N. Moore, L. P. Alford and F. A. Vaughn.

In order to meet the demand for a permanent employment service, the executive board of the council, at a recent meeting in New York, appointed a committee, passed a resolution and appropriated $2,000 for emergency employment work. The committee consists of Morris L. Cooke (chairman), William McClellan, W. E. Rolfe, H. E. Howe and William B. Powell. The resolution provides that the privileges of the Federation's employment service be extended not only to member societies, but also to those that are eligible for membership, for the rest of 1921. Each society is to pay the same amount per member as is paid by the American Society of Civil Engineers, which is a non-member, and this amount is to be prorated according to the portion of the year covered.

The important task of working out a policy of engineering education was assigned by the Committee on Procedure to a committee comprising Col. A. S. Dwight, Prof. Charles F. Scott and William W. Varney. It has been decided to go into the whole question of engineering education thoroughly, the object being "to consider broadly the training of the engineer and to report on desirable changes in present-day engineering education to better prepare engineering graduates to take their proper places in the profession," according to the resolution requesting the appointment of the committee.

## A.S.M.E. Working on Code for Miniature Boilers

The Boiler Code Committee of the American Society of Mechanical Engineers, after several months of active work on the question of a code covering the construction of the so-called miniature boiler, has prepared a report on a proposed code, which will be considered at a hearing to be held Dec. 6, at 10 a.m., in connection with the society's annual meeting in New York City. The hearing will be open to the public, and all who are interested in this branch of the field have been invited to be present or represented, so that the matter may be discussed from all angles, and any deficiencies in the code may be brought to light.

This work was undertaken some two years ago, but very little progress has been made up to this year, on account of difficulties involved in satisfactorily defining the word "miniature."

C. W. Obert, secretary to the Boiler Code Committee, has invited anyone who will be unable to attend the hearing to send in written comments on the matter, which may be addressed to him at 29 W. 39th St., New York, N. Y.

## Governor Allen Defends St. Lawrence Power Canal

At the joint meeting of the Metropolitan sections of the four engineering Founder Societies, held Nov. 14, in New York City, the St. Lawrence Ship Canal and Power Project was discussed. The speakers were: Hon. H. J. Allen, Governor of Kansas; Hon. W. L. Harding, former Governor of Iowa; Dr. R. S. MacElwell, Georgetown University; H. I. Harriman, president of the New England Power Co.; J. S. Barnes, president of the United States Grain Corporation. All spoke in favor of the project.

Governor Allen, who most enthusiastically favors the proposal, answered a number of statements made by Governor Miller of New York in a speech at Buffalo. Governor Allen pointed out the inability of the New York Barge Canal to handle the grain tonnage passing through the Great Lakes, claiming that the canal has a maximum capacity of less than 10 per cent of the grain passing Buffalo. Mr. Harriman spoke from the power viewpoint, showing that the returns from the electric power developed at the dams would pay all interest and sinking-fund requirements and would permit the ultimate electrification of the Eastern railroads. It was shown that a plant capacity of over 4,000,000 kw. is practicable, and that this power could be sold at rates far below those possible with the present coal-burning plants.

W. T. Saunders, chairman of the committee, read statements from New York commercial organizations opposing the canal project. He also regretted the inability of Governor Miller to accept the invitation extended him to present his objections to the canal development.

***WE HAVE probably the highest ingenuity and efficiency in the operation of our industries of any nation. Yet our industrial machine is far from perfect. The wastes of unemployment during depressions; from speculation and overproduction in booms; from labor turnover; from labor conflicts; from intermittent failure of transportation of supplies of fuel and power; from excessive seasonal operation; from lack of standardization; from loss in our processes and materials—all combine to represent q huge deduction from the goods and services that we might all enjoy if we could do a better job of it.***

Herbert Hoover, in a recent statement on the Elimination of Waste Report of American Engineering Council.

Recent additions to the membership of the Federated American Engineering Societies are the Vermont Engineers' Society and the Associated Engineers of Spokane.

## New Publications

**Steam and Oil Engines.** Published by the Vacuum Oil Co.. New York City. Distributed on Request.

Two instructive pamphlets, one dealing with oil engines of the surface-ignition type and the other with steam engines. Both are unusually well illustrated and take up the general principles of operation of the two types of engine, with especial consideration of lubrication problems, the latter being the most interesting and valuable phase of the books.

**Activities of the Bureau of Yards and Docks.** Published by the Superintendent of Documents, Government Printing Office, Washington, D. C. Cloth, 6 x 9 in.; 520 pages. Price, $1.25.

A review of the war-time work of the Bureau of Yards and Docks, which had charge of the design and construction of all public work and public utilities of the navy, comprising drydocks, shipbuilding ways, harbor work, power plants, coaling plants, heating, lighting and telephone systems, buildings, etc. The book has an unusually large number of good photographs and diagrams. Probably the only part of the book that is of direct interest to power-plant men is the chapter on Power Plants, covering 24 pages, which was prepared by L. W. Bates, project manager. The remainder, however, is decidedly interesting in the field concerned.

## Personals

**John S. Hester,** formerly superintendent of overhead and transportation of the Laurel (Miss.) Light and Railway Co., has succeeded A. B. Coryell as general superintendent and will also have direct charge of the power plant.

**Albert W. Smith,** formerly dean of Sibley College of Engineering, at Cornell University, who retired as president of the University upon the inauguration of Dr. Farrand, has become associated with the engineering firm of Henry R. Kent & Co., of Rutherford, N. J., as consulting engineer.

**M. H. Gerry** has become secretary, agent and engineer with the St. Anthony Falls Water Power Co. and the Minneapolis Mill Co. He had been engineer and power superintendent of the Metropolitan West Side Elevated Railway, of Chicago, and served as fuel administrator for Montana during the war. He built the first commercial power dam on the Missouri River.

**W. M. Bosworth** has left his work as assistant engineer in charge of contracts and production with the Underfeed Stoker Co. of America to accept a position as mechanical engineer with the Wine Railway Appliance Co., of Toledo, Ohio. He had been with the Underfeed company about three and one-half years and had formerly been mechanical engineer on a number of steam railroads.

## Society Affairs

### Coming Conventions

**National Association of Practical Refrigerating Engineers**—Annual convention at Hotel Lorraine, Philadelphia, Nov. 30-Dec. 3. Secy., Edward H. Fox, 5707 West Lake St., Chicago.

**Taylor Society**—Annual meeting at New York City, Dec. 1-3. Managing director, H. S. Person, 29 West 39th St., New York City.

**American Society of Refrigerating Engineers**—Annual meeting at New York City, Dec. 5-7. Secy., William H. Ross, 154 Nassau Street, New York City.

**American Society of Mechanical Engineers**—Annual meeting at New York City, Dec. 5-9. Topic, "Elimination of Waste." Sec., Calvin W. Rice, 29 West 39th St., New York City.

**Kansas City Section, A. I. E. E.,** will meet Nov. 25 for a talk on "Diesel Engines," by C. E. Beck.

**Schenectady Section, A. I. E. E.,** is to hold a meeting Dec. 2, at which the Superpower project will be discussed.

**Atlanta Section, A. I. E. E.,** is to meet Nov. 30. "Waterwheels" will be discussed by E. U. Gibbs, of the S. Morgan Smith Co.

**Hartford Branch, A. S. M. E.,** will meet Nov. 28 to discuss "Belting." In the afternoon an inspection trip will be made to the plant of the Jewell Belting Co., at Hartford.

**The Combined Associations of Manhattan, Bronx and Queens, N. A. S. E.,** will hold their twentieth annual entertainment and ball at Palm Garden, Fifty-Eighth Street and Third Ave., New York City, on Jan. 7, 1922. Any manufacturer or dealer who might be interested in becoming a patron, or in taking a box, should get in touch with the chairman of the finance committee, Samuel I. Schaff, 225 St. Ann's Ave., New York City.

## Business Items

**The American District Steam Co.,** North Tonawanda, N. Y., has recently announced the appointment on Oct. 1 of Warren S. Hillis as general sales manager. Mr. Hillis was for six years manager of the Chicago branch of the United States Radiator Corp.

**Payne Dean Limited,** 103 Park Ave., New York City, maker of Dean control for electrical operation of water, gas and high-pressure steam valves, has established offices in Pittsburgh and Chicago. C. J. Burrage, formerly in the engineering department of the Cutler Hammer Manufacturing Co., is in charge of the Pittsburgh office in the Bessemer Bldg., and A. H. Kohlbusch, previously superintendent of construction for the Public Service Electric Co., has been given charge of the Chicago office in the Lumber Exchange Bldg., 11 South La Salle Street.

## Trade Catalogs

**Textile Mill Power Equipment**—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 139, consisting mainly of illustrations showing the application of electric motors to textile-mill machinery.

**Valves and Regulators**—Atlas Valve Co., 282 South St., Newark, N. J. Junior Catalog No. 21, containing descriptions and prices of all sizes of reducing valves, pump governors, pressure regulators, etc.

**Transformers**—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1108. Mostly photographs, showing big power transformers installed and under construction, with descriptions of the process of making them.

**Boilers**—D. Connelly Co., Cleveland, Ohio. An attractive 32-page booklet that is unusually well illustrated with photographs showing the company's manufacturing methods. Some steam tables are also given, as well as a table of the carrying capacity of extra-heavy steam pipes and one showing the proper chimney sizes for different sizes of boilers.

## FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

| Coal | Market Quoting | Nov. 7, 1921 | Nov. 14, 1921 |
|---|---|---|---|
| Pool 1, | New York | $3.20 | $2.90@3.25 |
| Pocahontas, | Columbus | 2.55 | 2.25@2.75 |
| Clearfield, | Boston | 1.95 | 1.75@2.15 |
| Somerset, | Boston | 1.90 | 1.60@2.15 |
| Pittsburgh, | Pittsburgh | 2.15 | 2.10@2.20 |
| Kanawha, | Columbus | 2.05 | 1.90@2.15 |
| Hocking, | Columbus | 2.10 | 2.00@2.20 |
| Pittsburgh No. 8 | Cleveland | 2.15 | 2.05@2.15 |
| Franklin, Ill., | Chicago | 2.90 | 2.75@3.50 |
| Central, Ill., | Chicago | 2.50 | 2.25@3.00 |
| Ind. 4th Vein, | Chicago | 2.90 | 2.40@3.25 |
| Standard, | St. Louis | 1.95 | 2.00@2.10 |
| West Ky., | Louisville | 2.20 | 1.75@2.25 |
| Big Seam, | Birmingham | 2.15 | 2.00@2.25 |
| S. E. Ky., | Louisville | 2.30 | 2.00@2.25 |

**New York**—On Nov. 16, Port Arthur light oil 22@25 deg. Baumé, 5½c. per gal.; 30@35 deg., 7c. per gal., f.o.b. Bayonne, N. J.

**Chicago**—Nov. 12, for 24@28 deg. Baumé, $1@$1.10 per bbl.; 32@36 deg. 3@3½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

**Pittsburgh**—On Nov. 14 f.o.b. refinery, Pennsylvania, 36@40 deg., 7@7½c. Oklahoma, 24@30 deg., $1.15@$1.35 per bbl.; gas oil, 32@34 deg., 4@4½c. per gal., 36@38 deg., 4½@4¾c., 38@40 deg., 4¾@5c. per gal.

**St. Louis**—Nov. 12, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, $1 per bbl.; 26@28 deg., $1.10; 28@30 deg., $1.15; 32@34 deg., 2½c. per gal.

**Philadelphia**—On Nov. 14, 26@28 deg. Baumé, Oklahoma, $1.25 per bbl.; 30@34 deg., Oklahoma (group 3), 3½c. per gal.; 16@20 deg. Seaboard, 3¾c. per gal.

**Cincinnati**—Oct. 31, for 26@30 deg. Baumé, 5½c.; Diesel, 30@32 deg., 5¾c. per gal.; 32@34 deg., 6c. per gal.

**Cleveland**—Oct. 31, for 26@30 deg. Baumé, 4½c. per gal.

## New Construction

PROPOSED WORK

**Mass., Boston**—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to build a substation and distribution system at the Naval Dry Dock. Spec. 4550.

**Mass., Cambridge**—The Cambridge Electric Light Co., Blackstone St., is having plans prepared for a 1 story, 90 x 180 ft. electric station at plant. French & Hubbard, 210 South St., Boston, archts. and engrs.

**Mass., Everett**—C. H. Tenney & Co., Archts., 210 Devonshire St., Boston, are receiving bids for a 1 story, 70 x 70 ft. power station on Broadway and Oakland Ave. for the Malden Electric Co., 129 Pleasant St., Malden. About $70,000.

**N. Y., Buffalo**—R. T. Ford, Hotel Richford, 21 Arnold Pk., Rochester, is having plans prepared for a 12 story, 106 x 170 ft. hotel on Delaware Ave. J. F. Warner, 1036 Granite Bldg., Rochester, Archt.

**N. Y., Far Rockaway**—The National Housing & Land Development Corp., c/o G. and E. Blum, Archts., 505 5th Ave., New York City, is having preliminary plans prepared for a 400 x 412 ft. apartment and hotel on Bway. About $800,000. J. Fried, Pres.

**N. Y., Brooklyn**—The Brooklyn Edison Co., 360 Pearl St., is having sketches made for a boiler house, etc. at foot of 66th St. About $1,200,000. Private plans.

**N. Y., New York**—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install a reciprocating air compressor here. Spec. 4555.

**N. Y., New York**—W. Korn, c/o G. and E. Blum, Archts., 505 5th Ave., is having sketches made for a 14 story, 100 x 125 ft. apartment on 58th St. and Park Ave. About $1,000,000. C. Mayer, 110 West 40th St., Engr.

**Pa., Philadelphia**—Producers Cold Storage Co., c/o W. C. Benkert, Morris Bldg., is having preliminary plans prepared for a 10 story, 90 x 270 ft. cold storage plant on South and Bainbridge Sts. About $2,000,000. A. J. Sauer & Co., Deukla Bldg., engrs.

**Md., Baltimore**—S. T. Williams, 223 North Calvert St., is in the market for a 250 hp. Corliss engine and 2 boilers, 72 in. x 16 ft. or 72 in. x 18 ft. for 100 lbs. pressure.

**Va., Norfolk**—The Treasury Dept., J. A. Wetmore, Supervising Archt., Navy Dept., Wash., D. C., will receive bids until Dec. 2 for an ice making and refrigerating plant to be installed in the main hospital building for the U. S. Public Health Service Hospital, here, on Tanner's Creek Site.

**Va., Tacoma**—The Heaton Coal Co., L. L. Heaton, Pres., is in the market for electrical coal mining equipment including one motor generator set, A.C. 2200, D.C. 250, four 5 hp. mine hoists, two 10 hp. 75 G.P.M. electric mine pumps, 5,000 ft. No. 6 soft drawn copper wire, and 2,000 ft. No. 00 waterproof copper wire.

**Va., Wytheville**—R. P. Johnson, Wytheville, O. M. Johnson, Purch. Agt., is in the market for a 125 hp. Corliss engine, Hardie-Tynes preferred (used if in good condition).

**Va., Yorktown**—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until Nov. 30 for a dam, spillway, water mains, pumphouse, etc. Spec. 4514.

**W. Va., Clarksburg**—The Imperial Ice Cream Co. is in the market for refrigerating machinery and equipment for ice cream plants, capacity and location as follows: 100 ton, Huntington, W. Va.; 40 ton, Ashland, Ky.; 40 ton, Steubenville, O.; 40 ton, Staunton, Va.; 30 ton, Harrisonburg, Va., and 30 ton, Winchester, Va.

**Fla., Inverness**—The city voted $45,000 bonds for installing pumping equipment and laying water mains.

**Ala., Anniston**—The Natl. Forge Co. is in the market for one 25 hp. motor with starter, one 10 hp. and one 5 hp., all to be 220 volt, 60 cycle, 3 phase, 900 r.p.m.

**O., Cleveland**—Billings-Chapin Co., manufacturer of paint, 1163 East 40th St., is having plans prepared for a 4 story, 80 x 110 ft. factory on East 40th St. About $250,000. Lockwood-Green & Co., 1566 Hanna Bldg., Archts.

**O., Cleveland**—The Bd. Educ., F. G. Hogen, director, East 6th St. and Rockwell Ave., received bids for a heating plant for the school on East 116th St. and Corlett Ave. from the Spohn Htg. & Ventilating Co., East 45th St., $154,312; Feldman Bros., 10309 Barrett Ave., $161,034; and Warden & Lees Co., Prospect Ave., $163,985. Noted Oct. 25.

**O., Cleveland**—The Broadway Properties Co., C. E. Camp, Euclid Ave. and 46th St., is having plans prepared for a 2 story commercial and market building, including refrigeration plant, at 5800 Bway. About $500,000. A. C. Wolf, Swetland Bldg., Archt.

**O., Cleveland**—The Meyers West 25th St. Market Co., c/o Hulett & Stanton, archts., 3129 Scranton Rd., plans to build a 2 story, 89 x 120 ft. commercial and market building on West 25th St. and Meyers Ave. About $200,000. A refrigeration plant will be installed.

**O., Dayton**—The city plans to lay new cables and install boxes for police and fire signal system, also construct building to house switchboards. About $200,000. F. E. Eichlberger, City Mgr.

**O., Dayton** — The Natl. Military Home, c/o C. W. Wadsworth, will receive bids until Nov. 29 for a 3 story hospital, etc., including a steam heating system. About $500,000. Schenck & Williams, 908 Natl. Home Bldg., Archts.

**O., Germantown** — The Village voted $150,000 bond issue for water works system including pumping plant, etc.

**O., Massillon** — The State Dept. Public Welfare, Oak and 9th Sts., will receive bids until Nov. 30 for the installation of an air compressor in the Massillon State Hospital. About $6,000. H. M. Seabright, Engr.

**O., Newark**—The Consumers Product Co. is receiving bids for a 1 story, 40 x 60 ft. ice plant. About $40,000. A. C. Bishop & Co., 427 Guardian Bldg., Cleveland, archts.

**Ind., Indianapolis**—B. K. Gibson, Archt., 608 South Dearborn St., Chicago, Ill., is preparing sketches for a 15 story, 195 x 202 ft. hotel (Jackson) including a steam heating system. About $2,500,000. Owner's name withheld.

**Mich., Detroit**—The city, c/o C. H. Burroughs, 703 Jefferson Ave., is having plans prepared for a 1 and 2 story, 150 x 300 ft. art institution on Woodward Ave. and John R. St. About $2,000,000. Zantzinger, Borie & Medary, Otis Bldg., Phila., Pa., Archts.

**Mich., Detroit**—L. Smilansky, 1332 Book Bldg., is having plans prepared for an 8 story apartment including a steam heating system on Memorial Park. About $1,250,000. C. N. Agree, 416 Book Bldg., Archt.

**Mich., Detroit**—Wayne County, 1103 Real Estate Exchange Bldg., received bids for furnishing and installing electrical and mechanical equipment for operation of West Jefferson Ave. Bridge from the Fowler Electric Supply Co., 325 Huron St., Toledo, O., $34,809; Miller & York, Inc., 451 West Larned St., Detroit, $44,000; and Norwood Noonan Co., 116 West Illinois Ave., Chicago, Ill., $44,988. Noted Oct. 25.

**Mich., Detroit**—J. E. Whitcomb Constr. Co., 525 Woodward Ave., is in the market for derricks with boom turning attachment, three-drum hoisting engine, one ¾ yd. heavy duty clamshell and one 4 in. centrifugal pump.

**Ill., Quincy**—The city, c/o J. P. O'Brien, Mayor, is having plans prepared for additions and extensions to waterworks system including new centrifugal pumps and water basin, etc. About $200,000. W. R. Gelston, Quincy, Engr.

**Ill., Savanna**—The city, c/o C. Jenks, Pres., is having plans prepared for extensions to pumping plant and water mains. About $30,000. A. Schnell, 915 North 2nd St., Clinton, Ia., Engr.

**Wis., Rhinelander**—S. Miller Cold Storage Co., Marshfield, plans to build a 2 story, 80 x 150 ft. cold storage plant. About $150,000. Architect not selected.

**Minn., Fond-du-lac**—The Great Northern Power Co., 311 Alworth Bldg., Duluth, is having plans prepared for a power house and dam. About $1,000,000. Private plans.

**Kan., Larned**—The city, c/o W. H. Avery, Clk., is having plans prepared for improvements to pumping station, reservoir, laying new mains, etc. About $90,000. W. B. Rollins & Co., Railway Exchange Bldg., Kansas City, Engrs.

**Mont., Great Falls**—The Montana Power Co., J. C. Hobbins, Mgr., Central Ave., plans to build a hydro-electric plant and dam on the Missouri River below Mystic Falls. About $1,000,000.

**Mo., Caruthersville** — The Bd. of Pub. Wks. plans to improve waterworks system including an addition to pumping station, reservoir, and new mains. About $60,000. Engineer not selected.

**Mo., Kansas City**—The Clark Estate, 3312 Bway., will soon receive bids for a 12 story hotel (Embassy) including a steam heating system. About $2,750,000. W. W. Ahlschlager, 65 East Huron St., Chicago, Ill., Archt. Noted Nov. 1.

**Mo., Shelbina**—B. G. Lilly & Son plans to remodel and build addition to ice plant. About $30,000. Architect not selected.

**Mo., St. Louis**—Lowenstein Bros. Real Estate Co., 105 North 7th St., is having plans prepared for a 4 story, 144 x 250 ft. film exchange including a steam heating system on Olive and Theresa Sts. About $750,000. Widman & Walsh, Wainwright Bldg., Archts.

**Okla., Woodward**—The city will receive bids until Nov. 28 for an addition to electric light plant. About $35,000. Black & Veatch Mutual Bldg., Kansas City, Engrs. Noted Sept. 20.

**Idaho, Lakeview**—G. Faust plans to build ½ mi. box flume, penstocks and electric power plant. The Bd. of Reclamation, State of Idaho, has approved application for use of 10 sec.ft. water from North Cold Creek under 200 ft. head to develop 250 hp. Total cost, about $100,000. Engineer not selected.

**Ont., Dutton**—The Council, M. Blue, is having plans prepared for an electric lighting and power distribution system. About $50,000. J. N. Wilson, 90 University Ave., Toronto, Engr.

**Ont., Goderich**—The council, Mayor Wigle, Chn., is having revised plans prepared for a chlorination and filteration plant, gasoline pumping plant under consideration. About $55,000. F. H. Darling, 47 Home Bank Bldg., Hamilton, Engr. Noted June 28.

**Ont., London**—The London & Pt. Stanley Ry., is having plans prepared for installation of additional power units, enlarging terminals and construction of additional sidings. About $100,000. J. E. Richards, London & Pt. Stanley Ry., Engr.

**T. H., Pearl Harbor**—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install a Turbo alternator. Spec. 4548.

**South Africa, Vereeniging** — The Rand Water Bd., Director, Commercial Intelligence Service, will receive bids until Dec. 22 for 3 boilers, superheaters, stokers, feed pumps, etc., to be installed in the Vereeniging pumping station. W. J. Egan, Canadian Government Trade Comr., Cape Town.

## CONTRACTS AWARDED

**N. H., Concord** — The Boston & Maine R.R. Co., North station, Boston, has awarded the contract for a 1 story boiler house to H. Wales-Lines Co., 134 State St., Meriden, Conn. About $75,000.

**N. Y., New York** — The Alcas Realty Corp., c/o G. Nordham, Archt., 18 West 34th St., will build a 6 story apartment on Tremont Ave. and 178th St. About $750,000. Owner will build by day labor.

**N. Y., New York** — F. F. French, 299 Madison Ave., will build a 14 story office building an Madison Ave. between 39th and 40th. About $1,000,000.

**N. J., Newark**—L. Bamberger & Co. has awarded the contract for a 25 story addition to department store on Market St. to G. A. Fuller Co., 949 Bway., New York City. About $2,000,000.

**Pa., Philadelphia**—The Methodist Hospital has awarded the contract for a 6 story, 90 x 123 ft. hospital on Board and Ritner Sts. to Crampa & Co., Deucla Bldg., $300,000. A steam heating system will be installed.

**D. C., Washington**—The Bd. of Comrs. has awarded the contract for a New Eastern High School including mechanical equipment, to G. E. Wyne, Home Life Bldg., $959,700. Noted Sept. 6.

**N. C., Charlotte**—The Southern Power Co., c/o W. S. Lee, Church St., has awarded the contract for wheels and generators for addition to power plant at Great Falls, known as Great Falls Power House 2, 3 units, each 18,750 kva. capacity, also for new installation at point 12 mi. from here, known as Mountain Island Station, four 18,750 kva. units. Wheels to S. Morgan Smith Co., York, Pa., and generators to Allis Chalmers Co., Milwaukee, Wis. Bids will be receive until Dec. 1 for the construction work. The Mountain Island Section will include dam, penstocks, power house, etc.

**Fla., Fort Pierce**—The city has awarded the contract for 500 kva. addition to electric light plant including equipment to T. B. Whitted, 806 East Blvd., Charlotte, N. C., $60,000. Noted Mar. 1.

**W. Va., Charleston** — The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for an electric cable system at the Naval Ordnance Plant to the Greenwood Engr. Co., 407 Stock Exchange Bldg., Phila., Pa., $82,022. Noted Oct. 18. Spec. 4537.

**W. Va., Maben**—The Raleigh Wyoming Coal Co. has awarded the contract for a 1 story, 70 x 80 ft. power plant to the Rust Engr. Co., Engr., 1901 5th Ave., Pittsburgh, Pa. Noted Nov. 15.

**W. Va., Richmond** — The Cherry River Paper Co. has awarded the contract for a 1 story, 40 x 150 ft. powerhouse to J. H. Wallace, Beekman St., New York City. About $300,000.

**O., Bay Village** — The Northern Ohio Light & Power Co., c/o I. H. Case, Eagle Cliff, has awarded the contract for a 1 story, 80 x 100 ft. power plant, also electric lines to R. E. Carey Co., 1500 West 112th St., Cleveland. About $250,000.

**O., Cleveland**—The city has awarded the contract for a refrigeration plant to be installed in the City Hospital on Scranton Rd. to the Hibbard Co., Wise Bldg., Euclid Ave., $78,960.

**O., Minerva**—The Lewis Elec. Co., J. C. Lewis, Pres., has awarded the contract for a 1 story, 90 x 209 ft. factory to the Boldt Constr. Co., 5902 Euclid Ave., Cleveland. About $100,000.

**O., Toledo**—The city has awarded the contract for sewage pumping stations Nos. 1 and 2 to A. Bentley & Sons, Belmont Ave. and 13th St. Cost:, No. 1, $96,176; and No. 2, $274,789.

**Mich., Detroit** — The North Woodward Ave. M. E. Church, c/o C. B. Allen, 638 Hazlewood Ave., has awarded the contract for a 2 story church on Woodward Ave. to Bryant & Detwiler, 2336 Dome Bank Bldg. About $500,000. Noted Aug. 30. A steam heating system will be installed.

**Mich., Flint**—The Bd. Educ. has awarded the contract for a 2 story school to W. E. Wood & Co., 1805 Ford Bldg., Detroit. About $350,000. A steam heating system, boilers, etc., will be installed. Noted Oct. 8.

**Ill., Chicago**—The Bd. Educ., 650 South Clark St., has awarded the contract for a 3 story, 90 x 160 ft. school at 1727-39 Bellow Ave. to A. and E. Anderson Co., 19 South La Salle St., about $300,000, also a 3 story school at 7336-52 Chapell Ave. to the Carnegie Co., 189 West Madison St., about $400,000. Steam heating systems will be installed.

**Ill., Hampshire**—The city, c/o F. Channing, Pres., has awarded the contract for a waterworks system, including pumping station and mains, laying new mains, etc., to A. J. Kelly, Marengo. About $25,000.

**Ill., Joliet**—The Suburban Ice Co., c/o L. E. Stanley, Pres., La Grange, will build an ice plant, 100 ton capacity. About $60,000. Work will be done by day labor.

**Wis., Hartford**—Portz Bros. Malt & Grain Co. has awarded the contract for a 1 story 60 x 70 ft. power house to J. Thorn, Hartford. About $35,000. Noted Oct. 11.

**Minn., Cloquet**—The city has awarded the contract for a power house, power line, installation of water mains, furnishing and installing pump and motor, etc., to the Pastoret Constr. Co., 303 Sellwood Bldg. Duluth, $21,886. Noted Nov. 8.

**Minn., Duluth** — The Great Northern Power Co., 211 Alworth Bldg., will build a reservoir and 2 dams at White Face River, to serve as an auxiliary to company's main dam on St. Louis River, 16 mi. northeast of here. Work will be done by day labor under supervision of company's engineering force, 15th Ave. and West Superior St. Cost about $200,000.

**Minn., Forest Lake** — The city, T. J. Arends, Recorder, has awarded the contract for a well and pump house to F. G. Bauer, Forest Lake, $7,231; for equipment to the Sanitor Constr. Co., 3050 4th Ave., S. Minneapolis, $6,800. Noted Nov. 1.

**Tex., Edinburg**—The city, A. J. Ross, Mayor, has awarded the contract for electric light plant and waterworks system, including the installation of a double stroke pump, pump head and motor for driving same, 60,000 gal. elevated steel tank, also engine and generator, switchboard, 12 kva. transformers, etc., to the Gulf Machy. and Ship Supply Co., Galveston, $38,995. Noted Oct. 25.

**Col., Seibert**—The city has awarded the contract for the installation of a water system, including electrical pumping equipment, etc., to the Beeson Mchy. Co., 308 Mutual Bldg., Kansas City, $50,000.

**N. M., Fort Baynard** — The Treasury Dept., J. A. Wetmore, Supervising Archt., Navy Dept., Wash., D. C., has awarded the contract for the installation of mechanical equipment in the U. S. Public Health Service Hospital here to S. Faith & Co., 2427 Penn Ave., Phila., Pa., $204,277. Noted Oct. 25.

**Cal., San Diego**—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for boiler plant equipment to be installed in the Naval Base Hospital here to W. E. Kier Constr. Co., and the W. Simpson Constr. Co., P. O. Box 1415, $49,095. Noted Oct. 18. Spec. 4494.

**Ont., St. Thomas**—The Ontario Hydro Comn., A. Beck, Chn., London, will build a hydro-electric system for power and lighting for the Yarmouth Township. About $115,000. E. L. Lawlor, 90 University Ave. Toronto, Engr.